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A COMPACT FACTORY PLANT

Steam Equipment Used at the Works of C. H. Wheeler Mfg. Co. for Making Steam Apparatus

BY WALTER C. EDGE

THIS PLANT, FORMERLY all under one roof and run belt-driven, is now running by motor power with current generated and supplied from a power plant in a separate building. The office and draughting rooms are also separated from the main building, and fitted with all the latest appliances, including an ice-water installation.

beyond the building line toward the railroad, which passes the building.

This makes a coal bin with cement walls outside of the boiler room, directly in front of the boilers, the floor of which is part of the boiler room floor, making it convenient for the handling of coal, by unloading it practically into the boiler room.

The engine room is level with the ground, or 6 ft. 6 in. above the boiler room, and has a cement floor

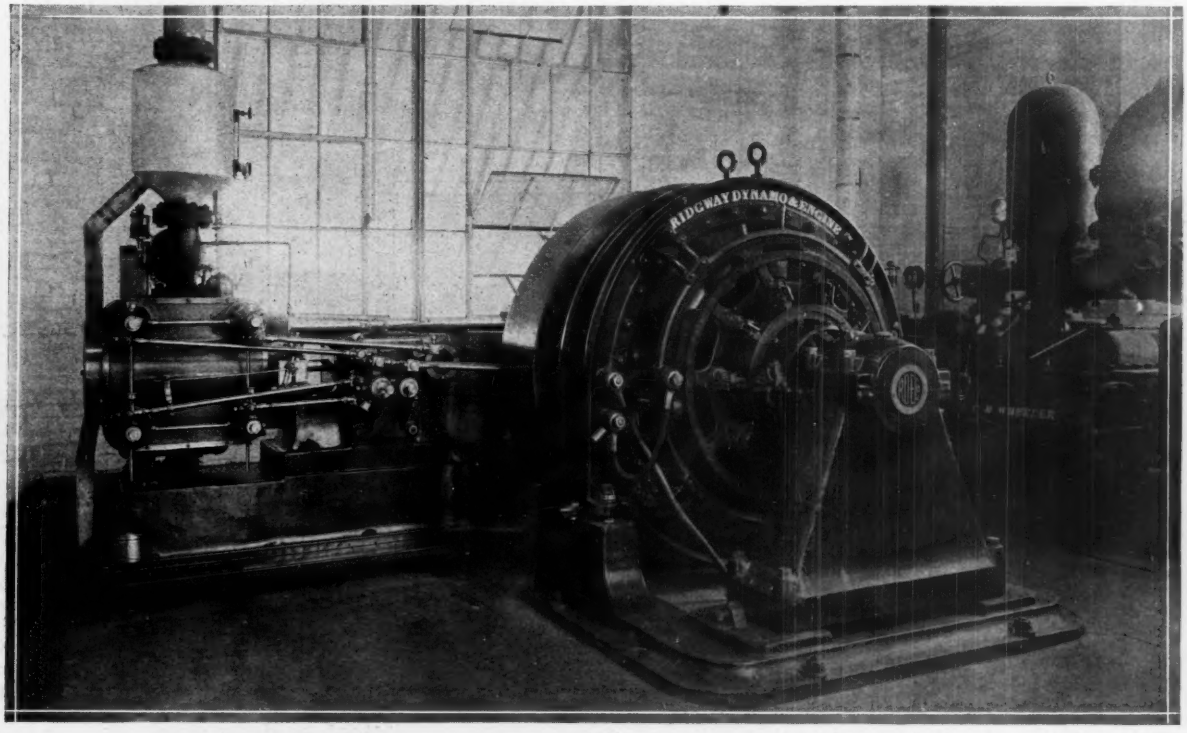


FIG. 3. THE RIDGWAY GENERATING UNIT AND FIRE PUMP

Twelve feet from the main building is the power house, a 1-story brick structure 54 by 25 ft. over all. The boiler room floor, of cement, is 6 ft. 6 in. below the ground, measures 50 by 25 ft. and extends 20 ft. with iron steps to the boiler room. The engine is set to one side of the room in order to make room for an additional engine at any time. Both the boiler and engine rooms are well lighted and ventilated.

Water Supply

WATER supply to this plant is city filtered and brought in by several mains under city pressure. Two 4-in. lines supply the water necessary for use in the plant, and 1 6-in. main is connected direct to the fire pump which in turn connects direct with the fire tank and sprinkler system. The pump can be by-passed, should it be necessary, and water forced through sprinkler system direct from the street via a twin connection placed outside for that purpose. The

Piping and Heating

THE steam pipe running to the engine is 6-in. extra heavy. The engine exhausts through a 6-in. pipe enlarged to 8 in. in order to receive another engine later on. This exhaust main supplies the steam used in heating the buildings. A vacuum system is employed, a Wheeler vacuum pump, set in the boiler room, creating the vacuum, and discharging the condensate into a Wheeler receiver, also in the boiler room. Live steam may be used for heating if necessary, a Ford

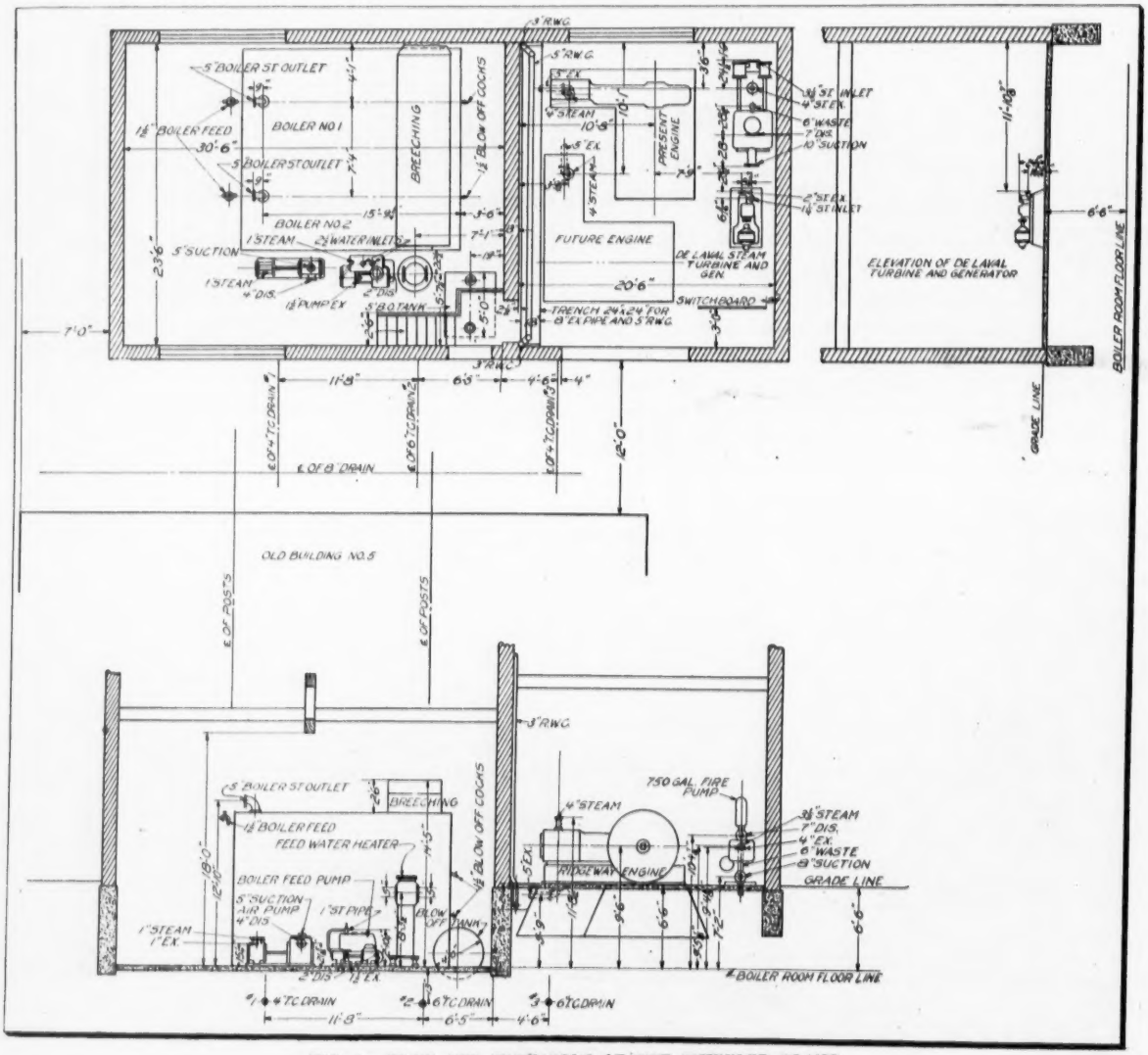


FIG. 1. PLAN AND ELEVATION OF THE WHEELER PLANT

fire pump, of Wheeler make, is 16 by 9 by 12, with a capacity of 750 gal. a minute. It is located in one corner of the engine room.

Boilers and Fittings

TWO Heine safety boilers, of 250 hp. each, are designed to work at 180 lb. pressure. They are protected from high or low water by Reliance safety water columns, and are equipped with P. B. H. quick-closing water gages, and P. B. H. weight gage cocks. The damper is controlled by a Spencer damper regulator.

reducing valve is used on the live steam line connecting the main steam line with the heating main, so arranged that live steam could be introduced into the heating main without entering the engine exhaust.

Method of Boiler Feed

THE Wheeler receiver affords an economical method of feeding the boilers, advantage being taken of all heating returns, as well as all trap discharges. To this receiver is connected the suction of the 6 by 4 by 6 boiler feed pump, regulated by a Waters pump governor. It is also piped to take the water direct

from the city main if necessary. Water going to the boilers is pumped through a 500-hp. closed type Wheeler heater, set in the boiler room alongside of the pump. The heater is by-passed, enabling the engineer to cut it out at any time. On the boiler room wall, discharging into the feed lines, is a 1½-in. Hancock inspirator, making another method of feeding the boilers. The feed lines are protected by a relief valve placed close to the pump.

Engine and Electrical Equipment

THE engine is a 12 by 14 Ridgway Corliss valve, running 225 r.p.m., double eccentric with self-contained oiling system, direct-connected to a Ridgway dynamo, rated at 75 kw.

It is protected from water in the steam line by a 6-in. Cochrane separator. One inch is the size of the drip line from the separator to an Anderson trap,

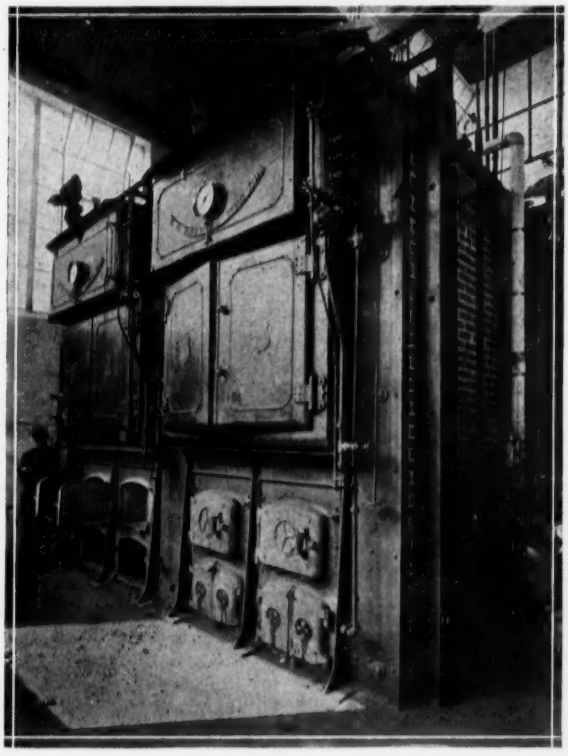


FIG. 2. A VIEW OF THE HEINE BOILER INSTALLATION

set back of the boilers, which in turn discharges into the receiver. The method of cylinder lubrication is force feed, a McCord force feed lubricator being employed. In addition to this, there is a hand force feed for emergency use. An emergency stop valve makes it possible to stop the engine, from the boiler room door, simply by pulling a pin.

The switchboard is of slate, wired so as to have power switches on one side and lighting on the other. The system of wiring is 3-wire direct current generated at 240 v. for power, and 120 v. for lighting, obtained by a neutral tap, an equalizing coil being used to balance the load.

Turbine

IN order to operate the plant as economically as possible, a small De Laval steam turbine is installed to take care of the night load, which is light owing to the fact that the shops do not run at night. The night load is all lighting.

Connected to the turbine is a Crocker Wheeler generator designed to take care of 40 amp. at 115 v. This generator makes 3000 r.p.m. at 150 lb. pressure, 1¼-in. steam supply, and 2-in. exhaust. A 1¼-in. Cochrane separator is used here.

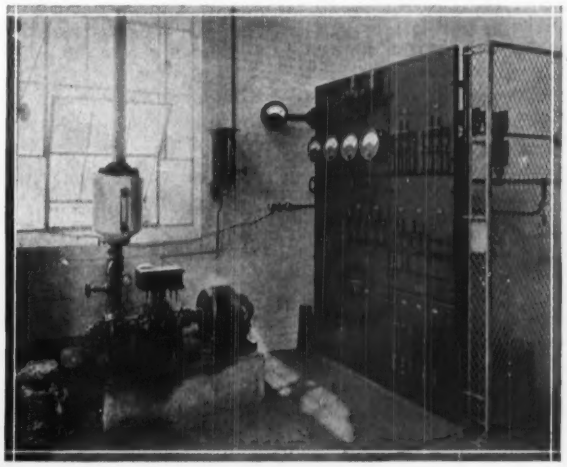


FIG. 4. LIGHT LOAD DE LAVAL GENERATING UNIT AND PLANT SWITCHBOARD

A gravity system of oiling is used.

Conduit and knob tube open work are the wiring methods employed.

The chimney is of steel, 130 ft. in height, 3 ft. diameter, erected by the Heine Safety Boiler Co.

Erecting Shop

ONE of the most interesting departments is the erecting shop. The pump parts and all other small work are machined in other shops or in the gallery,

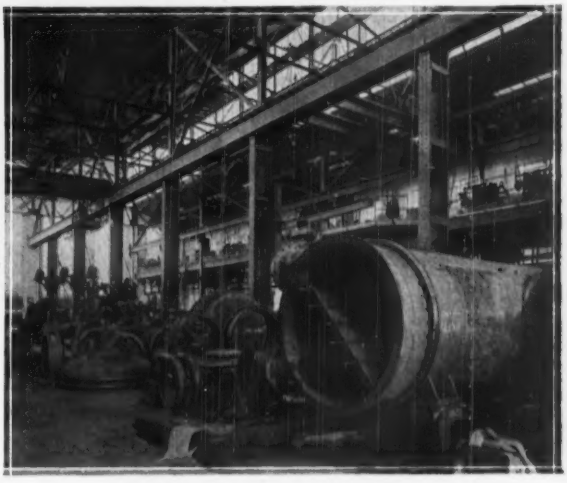


FIG. 5. IN THE ERECTING SHOP

and then sent to the erecting shop, where an able force of erecting engineers is kept busy assembling and testing.

The heavy work, such as boring large condensers, etc., is taken care of here by powerful machinery. In addition to the large boring mills and planers to be

found in this shop are 2 Pawling & Harnschfeger traveling cranes, one rated at 20,000 lb., the other at 50,000 lb., equipped with a 10,000-lb. auxiliary. There may also be found 2 4000-lb. and 6 small Shepherd electric jib cranes.

Along the east side of the shop there is a gallery equipped with all kinds of small machines of the latest type; some of them are direct-motor-driven, while others are shaft-driven, 3 or 4 machines on 1 motor.

This shop is exceptionally well ventilated and lighted; over ⅔ of the outer surface is glass. This plant was designed by R. G. Coolbaugh, to whom the writer is indebted for assistance.

HEATING AND VENTILATING LARGE BUILDINGS

Computing Radiation for Direct and Indirect Systems Using Steam and Hot Water

By Charles L. Hubbard

IT frequently happens in office buildings that partitions are changed more or less to meet the requirements of tenants. This often involves a re-arrangement of radiators, or the addition of new ones in some cases, and it will add to the value of the engineer's services if he is able to determine the required sizes without calling in outside assistance. Sometimes a room fails to heat properly and in searching for the cause it is often necessary to check up the size of radiator. The following method of computation is simple and also adapted to different grades of construction.

It is customary in the middle west and in New England to proportion the radiation for warming the building to 70 deg. when it is zero outside, and the following rules are based on that assumption. The heat loss from a building is due to 2 causes, transmission or conduction through wall and glass surface, and leakage around doors and windows, and through the walls themselves, to some extent. The first depends upon the thickness and construction of the wall, and the difference between inside and outside temperatures; while leakage is affected by the tightness of construction and the strength and direction of the wind. The points of compass to which a room is exposed also has a decided effect upon the amount of radiation required, due partly to the amount of sunshine which it receives and partly to the wind pressure.

The custom of basing the size of radiator upon the cubic contents of the room is not to be recommended, as the actual wall and window exposure may vary greatly in rooms having the same cubic contents.

For brick and terra-cotta walls of ordinary thickness, the following rule may be used:

Multiply the net outside wall surface by 25, the glass surface by 85, add the results, and divide by 250 for steam, and by 170 for hot water.

This gives the square feet of direct radiation for a room having a southerly exposure in a building of the very best construction.

For good construction, multiply the result by 1.1, for fair construction, by 1.2; and for poor construction, by 1.3. For other exposures than southerly, multiply the final result by the following factors:

North	1.32
East	1.12
South	1.00
West	1.20

Example: A room has 300 sq. ft. of outside wall surface, and 80 of glass, the building is of fair construction, and the room has a easterly exposure. How many square feet of direct radiation will be required for steam heating?

Solution,

$$300 \times 25 = 7500$$
$$80 \times 85 = 6800$$
$$14{,}300$$

and
$$\frac{14{,}300 \times 1.2 \times 1.12}{250} = 77 \text{ sq. ft.}$$

As previously stated, this rule is for a difference of 70 deg. between inside and outside temperatures. For other temperature differences multiply the square feet of radiation, as computed above, by the following factors:

Temperature difference	Factor
90 deg.	1.2
80 deg.	1.1
70 deg.	1.0
60 deg.	0.9
50 deg.	0.8
40 deg.	0.7

For example, if the outside temperature should fall to — 20 deg. in the case just worked out, it would be necessary to provide a radiator containing $77 \times 1.2 = 93$ square feet to heat the room to 70 deg.

If the coldest weather were + 20 deg. then only $77 \times 0.8 = 62$ sq. ft. would be required.

This table of factors applies equally well to cases where it is desired to maintain an inside temperature either above or below 70 deg. because the multipliers are simply for differences in temperature between the outside and inside, regardless of the actual temperatures themselves. While the radiating surface may be computed quite accurately for the average room, there are frequently cases where the result must be estimated to some extent, as well as computed. This of course requires a certain amount of experience for the best results, but the following hints will be of some assistance in making estimates of this kind.

For rooms on the top floor, with a cold attic or roof space above, increase the radiating surface from 10 to 20 per cent, according to the tightness of the roof construction. For entrance vestibules, double the radiating surface as computed from the wall and glass exposure. Sometimes in the case of the first floor corridors in office buildings and hotels it is necessary to triple the radiating surface near the entrances in order to warm the cold air as it comes in through the frequently opened doors.

In basement rooms overhead circulation coils are sometimes used in order to keep the floor and walls free for other purposes. When this is done, it is necessary to increase the heating surface at least 50 per cent above that required where the radiators are placed near the floor.

In the case of concealed radiators, the amount of surface will depend upon the openness of the grill

work and the freedom with which the air circulates over the heating surface. If generous openings are provided at top and bottom and a curved deflector placed over the radiator to turn the warm air into the room with the least possible resistance no change need be made in the size of radiator, but if the air passages are at all contracted, the surface should be increased from 10 to 30 per cent according to conditions.

If indirect heaters are used, taking their air supply from out of doors, first compute the amount of direct radiation required for heating the room and multiply this by 1.5. Although each square foot of indirect surface gives off at least twice as much heat as a square foot of direct, owing to the lower temperature and higher velocity of the air passing over it, additional heat is required to raise the temperature of the entering air to that of the room, and hence the greater amount of surface required.

When indirect stacks are supplied from a fan, with air at a temperature of 70 deg. the required amount of surface may be found by computing the direct radiation for the room and multiplying the surface thus found by 0.7. Less heating surface is required under these conditions on account of the higher velocity with which the air passes over it.

In the case of main heaters for use in connection with ventilating fans it is necessary to take into account the volume of air and its rise in temperature, also the depth and form of the heater.

To find the heat units required to raise a given volume of air through any number of degrees in temperature, multiply the volume, in cubic feet, by the rise in temperature in degrees, and divide by 55.

This process may be simplified by the use of the following table, which gives the degrees rise in the first column and a corresponding multiplier in the second. To use this, multiply the cubic feet of air to be warmed by the factor corresponding to the required rise in temperature, and the result will be the heat units required.

Rise in Temp.	Multiplier
50 deg.	0.9
60 deg.	1.1
70 deg.	1.3
80 deg.	1.5
90 deg.	1.7

Example: A building is to be supplied with 500,000 cu. ft. of air per hour for ventilating purposes at a temperature of 70 deg. How many heat units will be required per hour for warming this in zero weather? Solution: $500{,}000 \times 1.3 = 650{,}000$.

The square feet of radiating surface in the main heater is found by dividing the heat units required per hour by the efficiency of the heater, which may be taken as 1500 for the average conditions of ventilating work, where the air is to be raised from zero to 70 or 80 deg. above. If the heater is made up of 1-in. wrought-iron pipe it would be about 10 rows deep to give these final temperatures with steam from 1 to 5 lb. pressure. When a room is to be both heated and ventilated by means of hot air from a fan, the air is commonly introduced at a temperature of 90 to 100 deg., in which case the heater should be made from 12 to 14 rows of pipe deep and will have an efficiency of about 1400 for the higher temperature.

In the example given, the heater should contain $650{,}000 \div 1500 = 434$ sq. ft. of heating surface.

In case the heater is made up of cast-iron sections of the "pin" type a single row of 8 or 10-in. sections will give sufficient depth to produce a 70-deg. rise in temperature, while a 12 or 14-in. section is ample for a final temperature of 100 deg.

When a room is to be both heated and ventilated by hot air, the heat loss per hour from transmission and leakage should first be computed and corrected for exposure. To this should be added the heat units required for warming the air for ventilation. The sum of these 2 quantities, divided by the efficiency of the main heater (1400 for steam and 1100 for water) will give the square feet of surface required.

Example: A banking room has 1600 sq. ft. of outside wall surface and 400 of glass. The construction is good, and the exposure west. The air supply for ventilation is to be 90,000 cu. ft. per hour. How many square feet of surface should the main heater contain for steam?

Solution:

$$1600 \times 25 = 40{,}000$$
$$400 \times 85 = 34{,}000$$
$$74{,}000$$

Heat loss per hour by transmission and leakage $= 74{,}000 \times 1.1 \times 1.2 = 97{,}680$.

Heat loss per hour by ventilation $= 90{,}000 \times 1.3 = 117{,}000$

Total per hour 214,680

Required radiating surface in main heater $= 214{,}680 \div 1400 = 154$ sq. ft.

When hot water under forced circulation is employed instead of steam, the methods of computation are the same as those already described, except an efficiency of 170 is used instead of 250, in the rule for finding the direct radiation. All the other multipliers given for the various conditions noted are the same for both steam and water.

In the case of main heaters, use efficiencies of 1100 and 1000 for water in place of 1500 and 1400 for steam, for the ordinary temperatures at which the water is circulated, say an average of 180 deg.

If the water is circulated under pressure, at a higher temperature, the efficiency of the radiating surface will increase in proportion to the difference in temperature between the water in the radiators and the surrounding air.

POWERFUL ELECTRIC LOCOMOTIVES will haul the shipping through the locks of the Panama Canal. The locomotives will run on a raised track beside the canal and will receive their electric energy from a hydro-electric plant being built in connection with the Gatun dam. The gates of the mighty locks, weighing many tons, will be opened and closed by powerful electric motors in the remarkable time of 1 min. and 48 sec. The canal will be lighted by electricity and electric power will be used for many other purposes in connection with the work.

To supply the power to operate the gates and sluice valves in the locks, and to furnish current for the monster electric locomotives which are to tow the steamships through the locks, a great hydro-electric station is being erected adjacent to the spillway in Gatun dam, equipped with 3 large water turbines and 3 2000-kw. generators, with suitable exciters and other auxiliaries. There will be enough water from the storage in Lake Gatun to warrant the installation of 6000 kw., though in the dry season it will be necessary to draw upon the storage. Altogether it is figured that for this electric work 7 per cent of the minimum water system of the canal will be required. A part of the electricity is to be used for lighting the line of the canal. Altogether 7000 lamps will be installed at the locks.

VERTICAL CURTIS TURBINES*

Steam Control by Governors, Throttling and Emergency, by Nozzle Gear and Stage Valves

IN the first article of the series, foundations, alinement and general details of erection were considered. The details of construction and directions for operating will be taken up in this and future issues.

Throttle Valve

COMBINED balanced throttle and trip valve shown in Fig. 4 is used on the turbine. The valve spool and the balancing piston are a single casting and form a seat for a bypass valve which is attached to the valve stem. Steam is admitted from the inlet side of the valve to space above the piston, around the piston

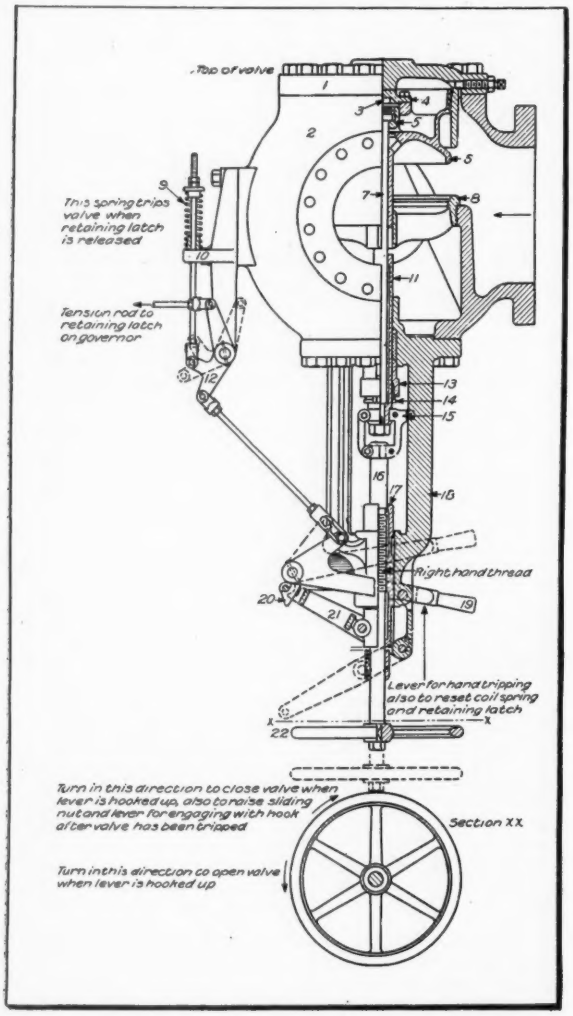

Top of valve
This spring trips valve when retaining latch is released
Tension rod to retaining latch on governor
Right hand thread
Lever for hand tripping also to reset coil spring and retaining latch
Turn in this direction to close valve when lever is hooked up, also to raise sliding nut and lever for engaging with hook after valve has been tripped
Turn in this direction to open valve when lever is hooked up
Section XX

FIG. 4. BALANCED EMERGENCY TRIP AND THROTTLE

1 Valve bonnet; 2 Valve body; 3 By-pass valve nut; 4 By-pass valve cover; 5 By-pass valve; 6 Valve spool; 7 By-pass valve stem; 8 Valve seat; 9 Trip spring; 10 Bracket for trip mechanism; 11 Spindle bushing; 12 Trip bell crank; 13 Large gland; 14 Small gland; 15 Yoke coupling; 16 Screw spindle; 17 Sliding nut; 18 Yoke; 19 Trip handle; 20 Trip hook; 21 Lever for sliding nut; 22 Handwheel.

and through a small port with an adjustable plug. Below the stuffing box the valve stem is threaded through a nut which slides through a guide in the yoke on the lower bonnet.

*Continued from page 1131, Nov. 1, 1912, issue.

Pinned to this sliding nut is a lever supported at one end by a link which is pinned to the valve yoke, and at the other end by a trip hook pivoted on the valve yoke and released either by a hand lever attached to its spindle or through a system of links by trip spring when the emergency governor throws out.

Design of the valve is such that there is always a slight closing pressure on the valve due to the unbalanced pressure on the area of the valve stem or sleeve on it which passes through the stuffing box. The valve seat being slightly larger than balancing piston, the valve is held positively to its seat.

Action of the valve is as follows: To open the valve turn the handwheel counter-clockwise when looking down on it; this immediately opens the bypass valve and the steam above the balancing piston is discharged through the small ports shown in the valve spool in the illustration and this relieves the

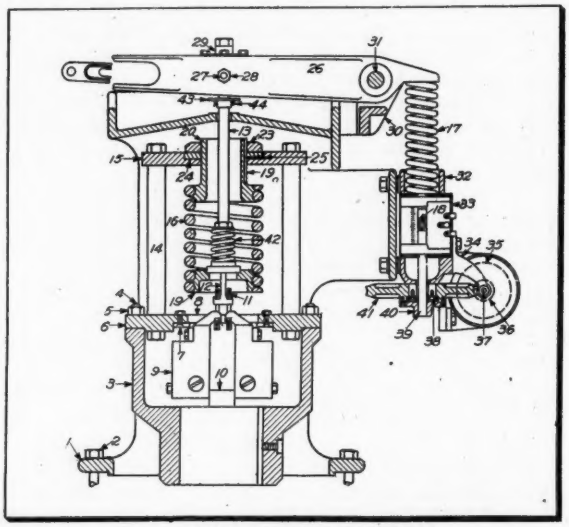


FIG. 5. MAIN TURBINE GOVERNOR

1 Dome; 2 Studs for (1); 3 Bracket; 4 Studs for (3) and (6); 5 Nuts for (4); 6 Bottom plate; 7 Fulcrum blocks; 8 Knife edge blocks; 9 Governor weight; 10 Stop bar; 11 Links and knife edge; 12 Yoke for links; 13 Spindle; 14 Studs for frame; 15 Top plate; 16 Governor spring (main); 17 Governor spring (synchronizing); 18 Synchronizing spring plug; 19 Main spring plug (upper and lower); 20 Adjusting screw; 21 Stud for (20); 22 Collar for (20); 23 Adjusting nut for upper spring plug; 24 Adjusting plate for upper spring plug; 25 Key for upper plug adjusting nut; 26 Beam; 27 Gimbal pivot for beam; 28 Nut for (27); 29 Gimbal transmission bearing; 30 Bearing bracket for beam; 31 Roller bearing for beam; 32 Bracket for synchronizing motor; 33 Limit switch; 34 Bracket for worm shaft; 35 Handwheel for synchronizer; 36 Worm for synchronizing gear; 37 Shaft for (36); 38 Support plate for worm wheel; 39 Synchronizing screw; 40 Cap for synchronizing screw; 41 Worm wheel; 42 Spring for universal joint; 43 Oil deflector; 44 Cotter pin for (43).

pressure above the valve. By further turning the handwheel the valve may be easily raised. Turning the handwheel in the opposite direction closes the valve.

Trip hook which supports the sliding nut may be released by raising the hand lever to which it is attached. When this is done, the valve spool has no support and the unbalanced pressure on the valve stem will force the stem and sliding nut downward and thus close the valve, and the lever attached to the sliding nut will drop to the position indicated by dotted lines. This action will take place no matter how wide open the valve may be when tripped. If the handwheel be then turned clockwise when looking

down on it, the sliding nut will be screwed upward on the thread of the valve stem until the attached lever again drops into the supporting hook. The valve may then be opened as explained above. After the valve has been tripped by emergency governor the mechanism may be reset (after speed of unit has dropped to normal) by forcing down the band trip lever attached to trip hook.

Valve stem packing is made with a double gland with a recess between from which any drip may be piped. If the valve is opened the spool should be drawn away with upper valve bonnet or pot by using an eye bolt through the hole in the center of the bonnet. In reassembling the valve, care should be taken that all bolts and screws on the inside of the valve are properly locked.

Operating Governors

ACTION of governors is dependent upon a balance between forces exerted by springs and the centrifugal efforts of weights. The springs of the governors are adjustable by a thread at the top and the weights are adjustable by the insertion of screw plugs. Governors are provided with auxiliary springs for varying the speed in synchronizing. If for any reason it is desired to change permanently the speed at which the governor operates, this should be done by adjusting the nut on the top of the governor.

These changes can only be made through a comparatively small range on either side of the speed at which the governor is designed to operate without affecting the regulation. If it is necessary at any time to increase or decrease the regulation of the

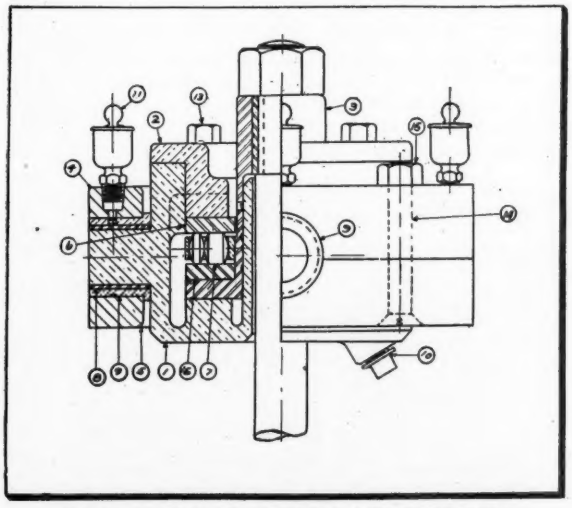


FIG. 6. SECTION OF GOVERNOR ROLLER BEARING

1 Bearing casing; 2 Bearing Cover; 3 Hub for roller race; 4 Supporting ring half; 5 Supporting ring half; 6 Roller race (upper); 7 Rollers and cage; 8 Bushing for (1); 9 Bushing for (4) and (5); 10 Plug for (1); 11 No. 00 oil cup (⅛-in. pipe threads); 12 Roller race (lower); 13 Tap bolt; 14 Cap screw; 15 Nut head.

governor this can be accomplished within narrow limits by inserting more lead in the pockets in the weights to diminish the regulation, and taking lead out to increase it. If a considerable increase or decrease in regulation is required, however, it should be secured by respectively decreasing or increasing the number of working coils in the main spring by screwing the top spring plug in or out. A quarter of a turn of the plug will make a considerable change in the regulation.

Positive action of any governor is necessarily dependent upon the absence of friction from its moving parts. All knife edges and joints should be renewed if wear causes any appreciable deterioration. In order that wear may be reduced to a minimum, the governor should be assembled in such a manner that all of its moving parts run as nearly concentric as possible.

Where the revolving part of the governor connects to the valve operating mechanism there is a roller bearing swivel called the governor transmission bear-

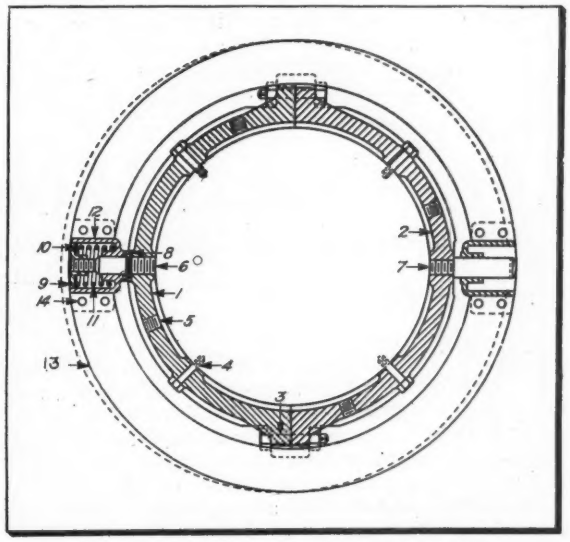


FIG. 7. RING TYPE EMERGENCY GOVERNOR

1 Emergency collar—spring half; 2 Emergency collar—stop half; 3 Bolt for collar; 4 Bolt for attaching collar to shaft; 5 Balance plug for collar; 6 Spring stud; 7 Guide stud; 8 Adjusting nut; 9 Spring support; 10 Lock washer for (9); 11 Emergency governor spring; 12 Spring box; 13 Ring (half); 14 Screw for ring.

ing. This swivel when clean and properly assembled is self-lubricating and should run for a considerable period of time without attention. If the swivel is already full of oil and if the circulation becomes congested, it will do little good to put in more oil, since it will simply overflow or be thrown out by centrifugal force. The swivel should operate without oil throwing, and if it does not so operate it should be cleaned with kerosene or taken apart and cleaned and repaired. All parts of governor should be frequently inspected so that any wear or deterioration will be discovered before it gives trouble. With everything properly arranged and adjusted there should be practically no wear.

Emergency Governor

SINCE any steam turbine can accelerate at a rapid rate, and since increase of speed may not be easily perceptible, it is important that all turbines be equipped with a simple speed-limiting device which can operate in case the regular governor device should fail. Several types of apparatus have been developed for this purpose; Fig. 7 shows the type used with this particular machine.

For machines rated at from 500 to 1500 kw. maximum inclusive, the emergency governor is of the double ring type and is placed on the operating governor bracket. Its only adjustment is the tightening or loosening of the spring to raise or lower respectively the tripping speed. Normally the governor runs concentric with the shaft. The trip finger is set ⅛ in. from the rings when they are concentric with the shaft.

For machines rated at from 2000 to 5000 kw. maximum inclusive, the emergency governor is of the single split ring type and has no collar on the shaft for supporting it. The emergency moves on studs extending into holes in the turbine shaft and runs concentric with it. When this emergency governor trips it moves in the opposite direction from that in which those used on other vertical machines move,—it goes out on the side opposite the spring. This emergency has but one adjustment, and that is tightening or loosening the spring for raising or lowering respectively the tripping speed. The trip finger is set ⅛ in. from the rings when they are concentric with the shaft.

For machines rated at 8000 kw. maximum and over, the emergency governor is of the single split ring type and is supported by a steel collar on the shaft. This emergency in its initial position has from 3/32 in. to 5/32 in. eccentricity, which eccentricity is adjusted by means of a small nut behind the spring box. It is evident that any increase in the initial eccentricity cuts down the effective travel of the emergency. This eccentricity should, therefore, be kept as small as possible within the above mentioned limits. Tightening or loosening the nut on the outer end of the spring box raises or lowers respectively the tripping speed. The trip finger is set ⅛ in. from the part of the ring farthest out of center when the emergency is in its initial position.

(To be continued in an early issue.)

THE EYERMANN STEAM TURBINE

Radial Turbines Working on Both Impulse and Reaction Principles, Built for Exhaust into Vacuum or Against a Back Pressure

By Alfred Gradenwitz

THOUGH nearly all steam turbines in practical operation are worked on the axial system, radial turbines possess some undoubted advantages of their own. The concentrical arrangement of blade rims on one disk, in fact, utilizes more satisfactorily the available material, the 2 faces in addition to the edges being used for the arrangement of active elements. Another advantage obtained in the case of steam admission from the inside outwards is due to the increasing circumference of blades which allows increasing cross-sections to be provided for the passage of the steam, with growing expansion.

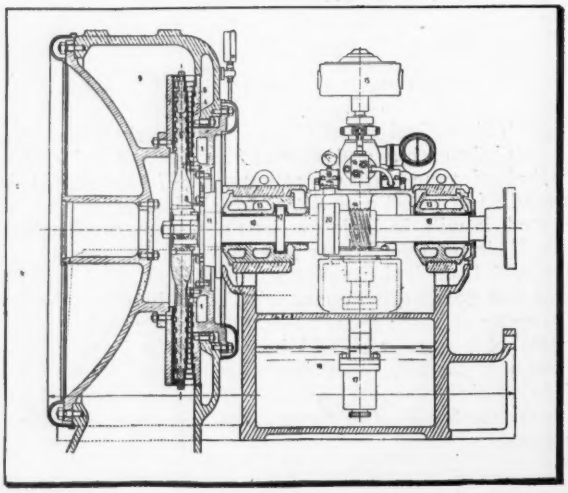


FIG. 1. CROSS-SECTION THROUGH EYERMANN TURBINE

Another essential point for the economy of radial turbines is a far more advantageous mode of working of the steam. In fact, in axial turbines, the steam in the rotating blades is thrown outwards by centrifugal force, thus assuming higher pressures and returning inwards in guides free from centrifugal force, which obviously impairs the efficiency of the blading. Furthermore, in any fairly long blades there are considerable differences inside and outside respectively in the average steam cross-section, as compared with the cross-section of the blade material and the peripheral speed, so that the blade angles frequently show considerable departures from the most advantageous figures. All these drawbacks are done away with in the radial turbine which, on account of its homogeneous steam passages, gives rise to no harmful secondary motion of the steam.

The fact that, in spite of all this, the axial turbine has reached its present supremacy is due, on one hand, to the serious constructive difficulties offered by radial turbines, and, on the other, to the prevailing opinion that 1 or 2 disks would not be sufficient for the arrangement of a sufficient number of rims. This, however, is quite possible when designing the first pressure stage fairly large (e.g., from 12 to 2 atmospheres absolute), the resulting speed energy being converted in 1 or 3 rotating blade rims and the remainder of the gradient being utilized in a limited number of blade rim pairs working on the reaction principle.

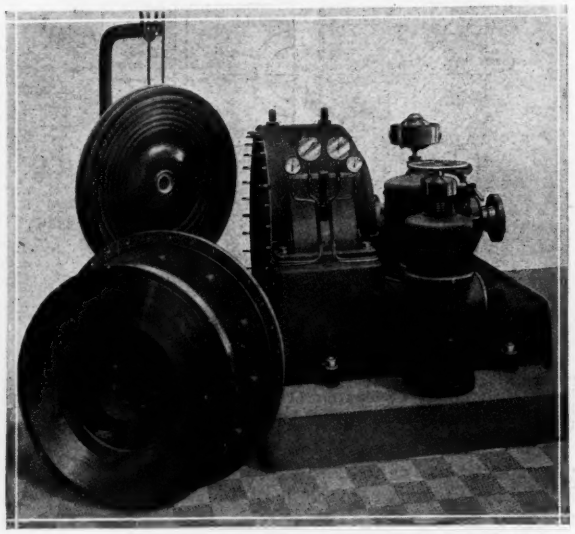


FIG. 2. EYERMANN TURBINE OF 1200 HP. WITH CASING REMOVED

Much attention has been paid recently to the radial turbine designed by W. H. Eyermann, of Steglitz, Germany, which has achieved remarkable success. This turbine has its blade rims arranged concentrically on a single disk, which of course involved a number of constructive difficulties. In order, in fact, to reduce the weight of the rotor, such strains as would result in the disk being bent had to be balanced by counter-forces. The steam expanding on its outward way through the blade rims exerts considerable axial pressure on the disk. This pressure is balanced by a small amount of steam expanding at the back of the disk in a number of labyrinth grooves, in a similar way to the working steam on the front side.

In order to allow the amount of balancing steam to be adjusted for, the turbine shaft is so arranged as to allow of an axial displacement of about ½ to 1 mm., thus altering the width of an annular throttling slot constituted by the stuffing box and the turbine disk, which slot is traversed by the balancing steam. Another factor liable to result in bending of the disk is the centrifugal force of the blading arranged on one side.

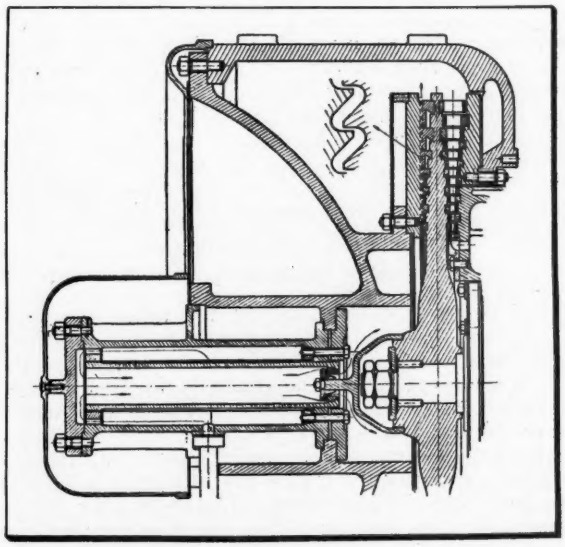


FIG. 3. AXIAL THRUST COMPENSATION OF 1200-HP. TURBINE

In order to compensate this, counter-weights, which also carry the labyrinth grooves, are arranged on the back in a similar manner to the blades provided at the front side of the disk.

As the number of blade rims which can be arranged on the disk is necessarily limited, each stage comprises a considerable pressure gradient liable to result in leakage losses between the blade ends and the stator or rotor disk. In order to reduce these losses to a minimum, the blade ends as well as the balancing side of the disk had to be fitted with a packing of simple design, ensuring satisfactory results even in the case of considerable clearances. This has been done in a most excellent manner by the arrangement of labyrinths.

Combination of Impulse and Reaction Principles

IN the high-pressure stages, partial admission in the case of small and medium capacities was found necessary on account of the small steam volumes, which can only be satisfactorily obtained on the impulse principle. Furthermore, on account of the stuffing boxes, the thrust on the housing and, on account of the heat expansion, the temperature of the housing, should be reduced. An expansion down to about 2 atmospheres absolute was therefore adopted in the high-pressure stage, the corresponding speed energy being converted in 2 to 3 speed stages, similarly as in Curtis turbines.

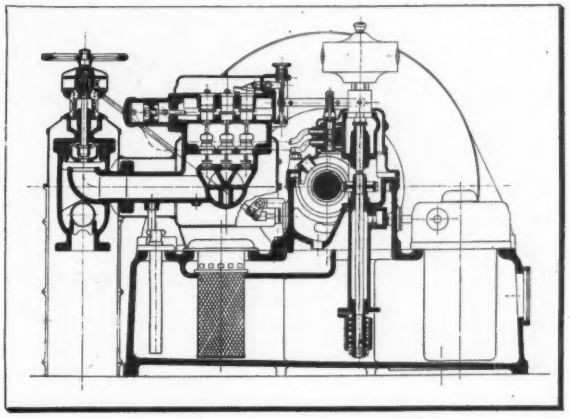


FIG. 5. CROSS-SECTION OF BACK-PRESSURE TURBINE

In the low-pressure part the reaction principle was adopted, thus allowing the same blade profile to be used in the stator and rotor bladings respectively and the number of stages required with a given efficiency to be reduced. The pressure gradient, in fact, distributes itself uniformly to the stator and rotor bladings respectively, so that the exhaust speed can in the following stage be utilized with fairly satisfactory efficiency. Since the losses due to the passage of the steam jet across the gap between 2 blade rims had to be of paramount importance, as compared with the friction and eddy losses in the blades, any reduction in the gaps to be bridged by the steam jet, and accordingly in the number of pressure stages, had to prove of advantage.

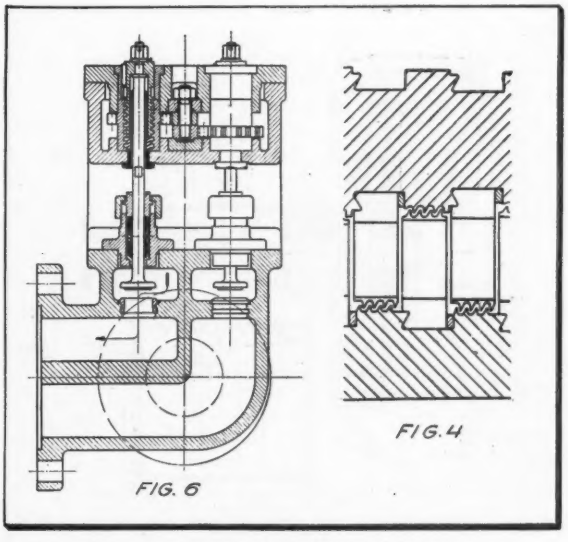


FIG. 4. ATTACHMENT OF TURBINE BLADING
FIG. 6. CROSS-SECTION OF NOZZLE STEERING OF BACK-PRESSURE TURBINE

Experimental Work

FOR experimental purposes a turbine of 250 hp. was constructed by Messrs. Swiderski, of Leipzig-Plagwitz, mainly for scientific tests, such as pressure and temperature measurements in all parts inclusive of the stator blades. The overhung disk carried 8 reac-

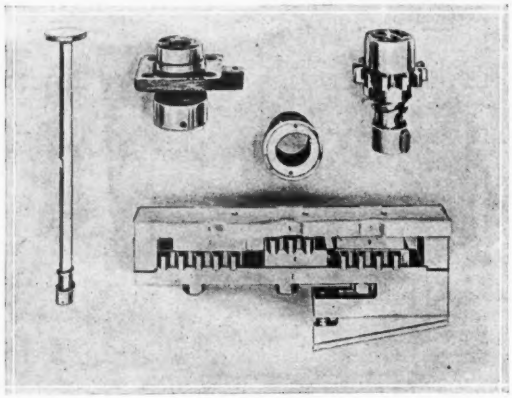


FIG. 7. PARTS OF NOZZLE STEERING

tion rims, and a ring fixed sideways comprised 3 action rims with steam admission from the outside inward. The high-pressure ring could be removed, thus allowing the low-pressure disk to be examined separately. Comprehensive tests partly made by Professor Josse, an authority on the subject, showed the total efficiency to be upwards of 50 per cent with a slight superheating and a 90 per cent vacuum. The efficiency of the high-pressure pipe was not found to be very advantageous, whereas that of the low-pressure blading proved excellent. These results induced the firm to take up immediately the manufacture of the new turbine.

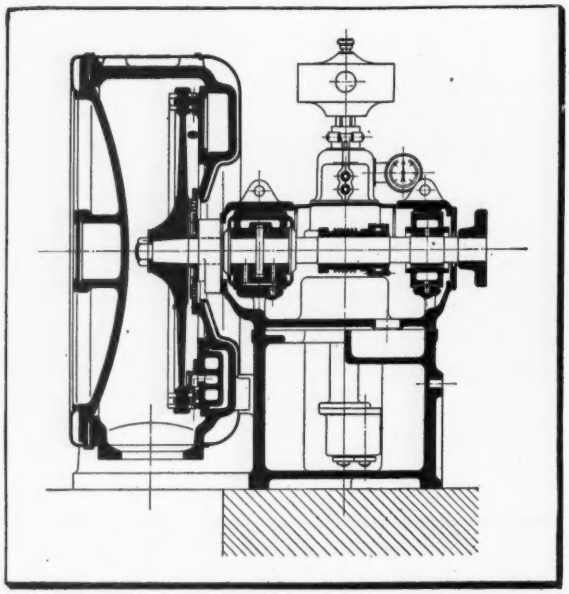


FIG. 8. LONGITUDINAL SECTION OF BACK-PRESSURE TURBINE

The turbine type next designed comprises the high-pressure and low-pressure bladings on the same disk. Figure 1 shows a longitudinal cross-section through a 500-hp. unit. After traversing the stopping, quick-locking and regulating valves, the steam enters the cast-steel ring 1 through a lateral tube fitting, expanding in the nozzles 2 to about 1.5 atmospheres absolute, yielding its speed to 2 rotor rims and eventually expanding in 8 further pairs of reaction rims down to condenser tension.

On account of the low weight of the rotor disk there was no objection to its being fixed overhung on the shaft end. The shaft is carried in 2 bearings

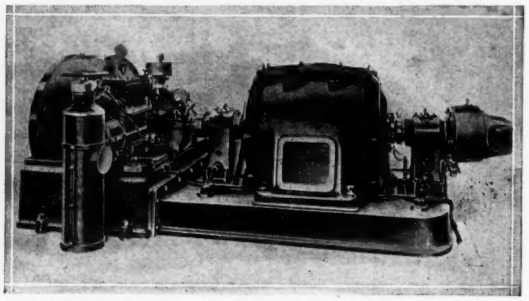


FIG. 9. SIEGWITZ 150-HP. BACK-PRESSURE TURBINE

between which are arranged the worm 14 for driving the regulator 15 and the oil pump 17, as well as a simple safety regulator 20 which, with any inadmissible increase in the speed of rotation, cuts out the quick-locking valve. After removing the lid of the housing and the rotor disk (by means of a special suspension device), the whole of the blading is disengaged and can be examined (Fig. 2). This dismounting is effected in 2 minutes.

Caring for Axial Thrust

THE labyrinth grooves arranged in accordance with the above at the back of the disk, in conjunction with those in a disk 7 fixed to the lid, allow the steam admitted to this labyrinth packing to expand in a similar manner as in the blades. The steam pressure at the back of the rotor disk is controlled as follows. Part of the steam having traversed the nozzles enters between a stationary ring 8 and the rotor disk, and through holes in the latter into the interior of the labyrinth. The shaft, as above mentioned, allows of a

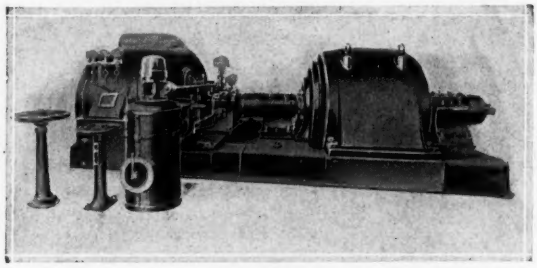


FIG. 10. TURBO GENERATOR PLANT OF 1700 HP.

slight axial displacement, thus deviating, e.g., to the right, in the event of the pressure to the left on the disk being excessive, thus reducing the width of the slot at 8 and the steam admission to the labyrinth and accordingly bringing the steam pressure down to its proper figure. The displacements required to effect this are little more than a tenth of a millimeter with all steam pressures and temperatures occurring in actual practice. The axial motion of the shaft is limited by a collar 12 of about 1 mm. axial play on the bearing.

Figure 3 represents a somewhat different arrangement which allows considerable energies transmitted from outside to the shaft to be readily dealt with. The balancing steam is here branched off in front of the nozzles, thus reaching the throttling slot (which in this case is arranged towards the lid) at a higher pressure. The heat expansion of the housing is compensated for by fitting the throttling ring to a double tube of cast iron and copper which, in conjunction with the housing, works in a similar manner to the compensating pendulum used in clocks.

The counter-weights arranged at the back side of the rotor disk are seen in Fig. 3. Their outside surface carries the labyrinth grooves, the form of which is represented separately in the figure. This profile can readily be produced and has been found to give an especially intense throttling effect.

The construction and mode of fixing of the blades are important factors for the safety of operation. Both the rotor and stator blades are made from the solid metal, the front and back profiles being milled, while the half-dovetailed feet are worked on the lathe in a special chuck for each blade rim, the packing grooves at the blade end being turned in on the rotor or stator disk with their blading in position, by means of slightly wedge-shaped spacing blocks (Fig. 4).

Figure 2 shows a disk 1700 mm. (66.929 in.), in diameter, for 1500 hp. with 1500 r.p.m. This has been manufactured with such care that the eccentricity in the centers of gravity of the disk does not exceed 0.05 mm. (0.01969 in.).

The stuffing boxes comprise a steam lock preventing the entrance of air in the event of there being a partial vacuum in the interior. Labyrinths are generally used, but a coal ring stuffing box has been recently adopted with excellent results.

Governing

REGULATION is generally effected by throttling the steam admission, the cutting out of nozzle groups (as represented in Figs. 5, 6 and 7) being resorted to only in special cases. Six cast-in channels locked against the live steam admission by 6 valves arranged in 2 rows (Fig. 5)—the spindles of which are lifted and lowered by the rotation of nuts (Fig. 6)—are leading to the 6 groups of nozzles. The nuts are turned around by a ruler actuated by an oil piston and which comprises racks of different length (Fig. 7) turning the nuts around in succession so that only one valve is throttling at a given moment, while the others are entirely open or closed. It may be said that this means of regulation is found really useful only in the event of the back pressure being nearly constant, as in the present case. This turbine is a 100-kw. unit, the exhaust steam of which is used for heating at a pressure of 1.1 atmosphere (absolute); Figs. 8 and 9 are a longitudinal section and general view respectively of this turbine which is in operation at the Sieglitz dyeing mill, Leipzig. While the general arrangement is practically the same as above described, the low pressure stages have been dispensed with.

Use of part of the working steam for heating and the utilization of the exhaust from other engines in low-pressure turbines has resulted in the design of a special turbine type. This is characterized by steam being taken from or supplied to a given point in the steam path of the turbine. As this, in the simple turbine above described, though not being unfeasible, is not convenient from a constructive point of view, Mr. Eyermann has preferred separating the high-pressure disk from the low-pressure disk. This arrangement which is still simple, affords the advantage of allowing all possible types such as back pressure, tapping, exhaust steam and normal turbines, to be manufactured with the same elements, thus utilizing the patterns to better advantage.

Figure 10 shows a turbine of 1700 hp. (1200 kw.), run at 3000 r.p.m. installed at Messrs. H. Otto & Sohne's Spinning Factory at Unterboihingen, Wurtenberg, which has its low-pressure blading on both sides of the low-pressure disk, while the arrangement otherwise agrees in all essentials with that above described.

The following are some data relating to the steam consumption, as ascertained by official tests. The back-pressure turbine of Messrs. Sieglitz, Leipzig, gave the following data:

Output Eff. Hp.	Admission Pressure Atmos. Abs.	Admission Temperature Deg. C.	Back Pressure Atmos. Abs.	Steam Consumption, Lb. per Eff. Hp.-Hour
150	9.24	305	1.01	27.6
112	9.36	287	1.01	29.8
75	9.54	286	1.01	34.0

The turbine of Messrs. Gebruder Otto, Unterboihingen, gave the following:

1200	12.35	331	0.025	12.3
720	11.25	325	0.022	16.0

The last-named figures relate to the effective outputs, i.e., exclusive of 35 hp. condensing work.

In another unit under construction in Belgium, the regulator is arranged on the main shaft and a separate oil pump is provided in connection with a new means of regulation, thus ensuring another simplification in the design of the turbine.

IN SELECTING TOOL STEELS from the rack where they are kept, several Canadian manufacturers have adopted the scheme of using colors for marking the various grades. This scheme is quite common in United States factories. The manufacturing committee of a large automobile establishment devised a color scheme for marking different kinds of steel used in their tool room, partly to prevent serious results due to error and partly for the sake of economy. There are approximately 20 different grades of steel, such as tool, high-speed, self-hardening, and so on. All of them greatly resemble one another in appearance and are generally known by certain trade names. Each is especially adapted to a particular use, having its individual application in some part of the shop.

The workmen, as a rule, know comparatively little about the relative merits of the different grades, and it is even difficult for the expert to distinguish between them.

It is the practice in this automobile factory to specify the steel by name on the design drawing and, of course, it is purchased by the trade name. But as soon as a shipment of it is received and delivered to the raw material stockroom, one end of the rods or bars, is marked by the stockkeeper with a strip of paint of the color by which that brand is designated.

Charts having one column for the actual color and another for the corresponding trade name are posted at convenient places about the shop. The colors are not put in by name, but an actual sample of the paint is used. —The Canadian Manufacturer.

THE CHIEF SMOKE INSPECTOR of Cincinnati estimates that the damage in that city from smoke amounts to one hundred dollars a family, while Dr. Holdsworth placed the Pittsburgh loss at twenty dollars per capita.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PRACTICAL ELECTRICAL ENGINEERING

Hysteresis, Eddy Currents, Reasons for Using Laminated Iron or Steel; Magnetic Circuits for Alternating-Current Magnets; Features of Alternating-Current Magnet Design

WHEN designing electromagnets for alternating-current circuits, several factors enter into the calculations, that do not have to be considered in connection with direct-current magnets. When magnetism in iron or steel is rapidly reversed, by the reversal of the magnetizing current the magnetic substance opposes the reversals, which results in heating of the metal and a loss in watts independent of the I^2R loss due to the resistance of the coil windings.

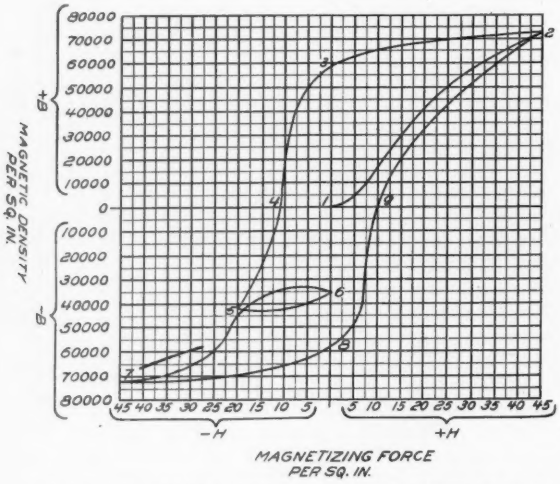


FIG. 1. HYSTERESIS CURVES FOR SOFT SHEET IRON

This phenomenon is known as hysteresis and the losses due to it depend upon the quality of the magnetic substance, the volume of the metal magnetized, the frequency of the circuit and the maximum magnetic density. There are numerous more or less complicated theories as to just what takes place in a magnetic substance during rapid reversals of magnetism, but it is sufficient for us to accept the fact that hysteresis exists and learn its effects.

Before studying the hysteresis curves, let us consider residual magnetism which may be defined as that which magnetic substances retain after the magnetizing force is removed. When a magnetic substance contains no residual magnetism it is said to be neutral.

Referring to Fig. 1, the curve 1-2 shows the relation between magnetic density and magnetizing force in soft sheet iron which was neutral before the magnetizing force was applied. At 2 the magnetizing force starts to decrease but the magnetic density of the iron does not decrease in proportion, as it will be seen that at point 3 the magnetizing force is zero but the magnetic density of the iron is about 58,000 lines per square inch. At point 4 the magnetic density is zero but there is a negative magnetizing force of about —11, that is, the magnetizing force has reversed by reason of the reversal of the current.

Thus it has required a negative magnetizing force of —11 to remove the residual magnetism. Negative magnetizing force when performing this function is called coercive force and may be defined as the magnetizing force necessary to remove completely the residual magnetism.

At point 5, the magnetizing force was 20, but was reduced to zero and quickly returned to 20, forming a hysteresis loop 5-6; it was then increased to 45 at point 7. From point 7 the magnetizing force is gradually reduced to zero at point 8, but the magnetic

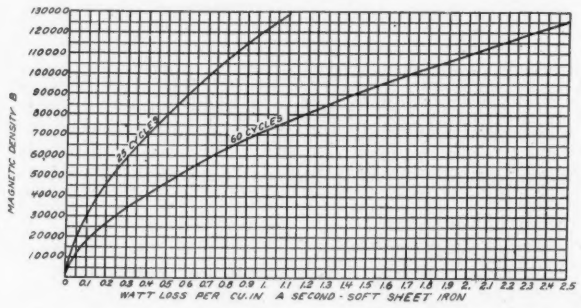


FIG. 2. CURVES SHOWING WATT LOSS FROM HYSTERESIS

density is about 58,000 corresponding with point 3. Point 9 corresponds, nearly, with point 4, where the magnetic density is again zero, but the coercive force is about the same as at point 4.

Curves from points 2 to 7 and back to 2 complete a cycle, and were it not for hysteresis the magnetic density would have decreased with the decrease of magnetizing force along the curve 2-1 and would have increased and decreased over a similar single curve from 1 to 7 and return, if the magnetizing force had been increased and decreased at a uniform rate.

The direct effect of hysteresis is a loss in watts and its extent depends upon several conditions already enumerated. Fig. 2 gives curves showing hysteresis loss in watts per cubic inch a second of soft iron at different magnetic densities, for 25 and 60-cycle circuits. Assume that we have an electromagnet with a core 2 in. in aria and 5 in. long, containing 10 cu. in. of soft sheet iron; that the magnet winding

is connected to a 25-cycle alternating-current circuit and the maximum magnetic density is 100,000 lines a square inch.

From the vertical column of densities follow to the right until the horizontal line intersects with the 25-cycle curve, then directly below in the horizontal row of figures read: 0.7 nearly, then $0.7 \times 10 = 7$, the watt loss. Similarly we can find the watt loss for 60-cycle circuits by following along the horizontal line to the right until it intersects with the 60-cycle curve and find the loss per sq. in. in the horizontal row of figures immediately under the intersection.

Eddy Currents

IN our study of electromagnetic induction we learned that if a coil of wire such as a helix, is placed inside of a larger coil, and an alternating current is passed through one coil, current will be induced in the windings of the second coil. If we place a solid iron or steel core in a coil through which an alternating current is flowing currents will be set up in the core metal, called eddy currents, the magnitude depending upon the density of magnetism in the core and frequency of reversal, the effect being to heat the core and cause a loss of energy.

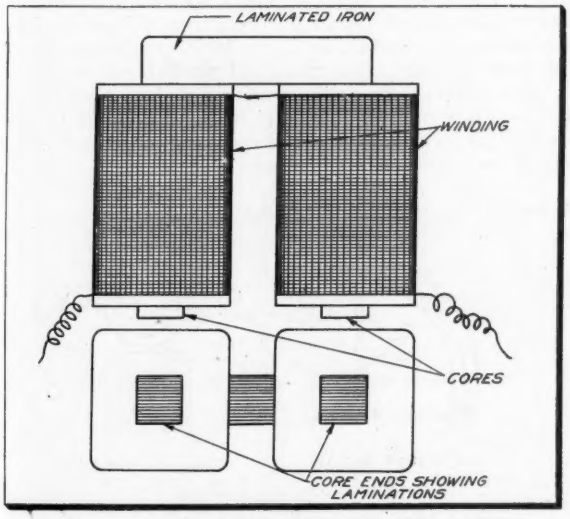


FIG. 3. ALTERNATING-CURRENT TRACTIVE MAGNET

To reduce eddy current losses to a minimum, the cores of alternating-current magnets are generally made of soft sheet iron, or soft steel punchings, fastened together as shown in Fig. 3, which illustrates a heavy alternating-current tractive magnet of the horseshoe type. The surface of sheet iron and steel for electrical purposes receives special treatment which offers high resistance to the passage of electric current; therefore, as the core or magnetic circuit is made up of many sheets of iron or steel insulated from each other, the eddy currents are greatly reduced below those in a solid mass of metal.

Metal spools used for electromagnets must not form a continuous connection as eddy current losses would again be encountered; they are slotted as shown in Fig. 4, to destroy the continuity of the conducting material of the spool.

There is another factor to be considered. In alternating-current magnets of the plunger type, operating on single-phase alternating-current circuits, the current varies from zero to maximum and back to zero twice during each cycle. This causes vibration of the plunger against the stop, creating considerable noise which can be relieved by placing a coiled spring between the stop and the plunger.

Special Magnets

IN telephone and telegraph work polarized magnets are largely used; the details of a telephone ringer magnet are shown in Fig. 5. The electromagnets, yoke and soft iron armature are essentially the same in construction as a direct-current modified horseshoe magnet with the exception that the armature is pivoted at its center and free to move on this axis. The armature is supported by the brass rods and a brass crosspiece which perform no other function.

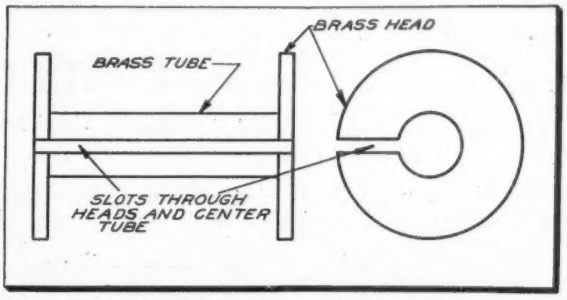


FIG. 4. CONSTRUCTION OF METAL SPOOL FOR ALTERNATING-CURRENT MAGNETS

A permanent magnet is attached to the yoke and extends downward and under the armature, thus maintaining the constant polarity in the armature. When no current is flowing through the coils of the electromagnets, if the lower end of the permanent magnet is a south pole, the armature will be a south pole and the lower ends of the cores of the electromagnets will

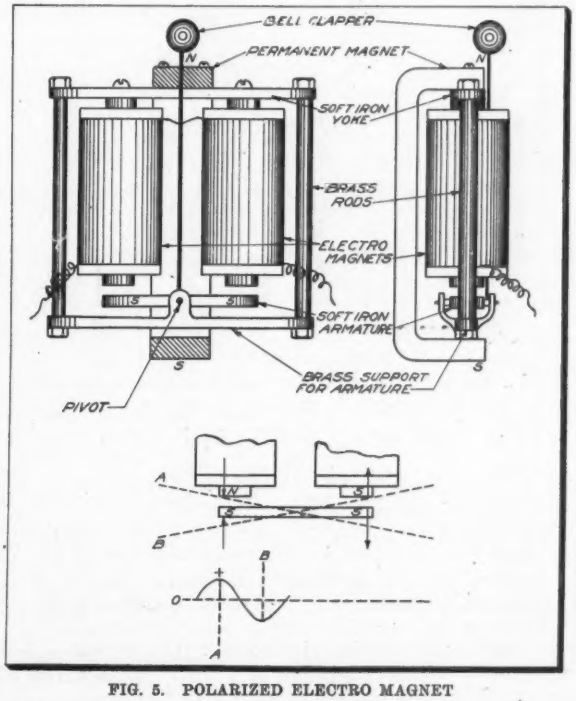


FIG. 5. POLARIZED ELECTRO MAGNET

be north poles. The magnetic circuit of the permanent magnet is from the north to the south pole through the permanent magnet, thence to the armature and cores and through the yoke to the point of beginning. When no current is flowing through the coils of the electromagnets, the armature will tilt and remain in contact with one or the other core.

Referring to the diagram in the lower part of the figure; if starting at zero, an alternating current is passed through the windings for a half cycle and the direction of the current through the winding is such that the lefthand pole is north, the righthand will be south, the effect being to strengthen the north pole as the magnetizing force of one coil is added to that of the permanent magnet; but in the righthand magnet the magnetizing force of the coil is greater than that of the permanent magnet; and opposed to it, therefore there will be a south pole at its tip.

As like poles attract and unlike poles repel each other, shown by the arrows, the armature will take a position along the line A. As the current passes zero in the first half of the cycle, the conditions will be exactly reversed and the armature will assume a position along the line B. Thus it will be seen that the armature changes position twice during each cycle of the current flowing through the magnetizing coils.

CONDUIT WIRING

Advantages of Conduit, Lined and Unlined, with Tables of Dimensions

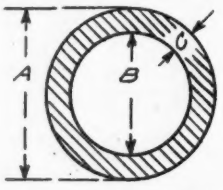
By O. N. Casey

RIGID iron conduit wiring is approved for both exposed and concealed work, and for use in nearly all classes of buildings. For ordinary conditions, wiring in iron conduit is probably the best, although it is the most expensive. The advantages of iron conduit are: It is fireproof and moisture proof; it is strong enough mechanically so that nails can not be driven through it and it is not readily deformed by blows or by wheelbarrows being run over it; it successfully resists the normal action of cement when imbedded in partitions or walls of fireproof buildings.

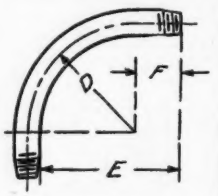
Lined and unlined iron conduit can be obtained; the lined conduit is merely ordinary conduit lined with a paper tube that is treated with an insulating waterproof compound. The lining is cemented to the interior of the conduit by the compound.

Advantages of unlined conduit over lined conduit are: It is cheaper because it has no lining; a smaller size conduit can be used for conductors of a given size; it is cheaper to install, as it can be bent, threaded and cut more readily than can lined conduit; it is easier to draw wires into and out of unlined conduit, than into and out of lined conduit; in lined conduit in hot places, the conductors sometimes stick to the lining, which prevents their withdrawal.

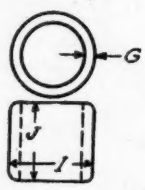
TABLE 1. DIMENSIONS OF UNLINED WROUGHT-IRON ELECTRICAL CONDUIT, ELBOWS AND COUPLINGS



SECTION OF CONDUIT



CONDUIT ELBOW



CONDUIT COUPLNIG

Nominal Size	A Outside Diam.			B Inside Diam.			C Thickness of Walls			Nom. Wt. lb. per ft.	D	E		F	I	J	G	
	Actual	Fractional inches to 64ths	In 64 to nearest 64	Nominal	Fractional ins. to 64ths	In 64 to nea rest 64	Nominal	Fractional inches to 64ths	64ths to nearest 64		Rad. of C	Offset inches	Wght. lb. of 100	Length Straight Portion	Outside Diam.	Length	Thickness	Weight of 100 in lb.
½	.84	27–32	54–64	0.623	5/8	40–64	0.109	3–32	6–64	.85	4½	7½	73	2 5/16	1 3–32	1 1/16	¼	15½
¾	1.05	1 1/16	68–64	0.824	53–64	53–64	0.113	7–64	7–64	1.12	5⅜	9½	132	3½	1 11–32	1 9–16	19–64	25½
1	1.315	1 21–64	84–64	1.048	1 3–64	67–64	0.134	⅛	8–64	1.67	5¾	10½	200	4⅜	1 21–32	1⅜	11–32	40½
1¼	1.66	1 42–64	106–64	1.380	1 34–64	88–64	0.140	9–64	9–64	2.24	7½	11½	300	3 7/16	2	1 15-16	11–32	57½
1½	1.90	1 29–32	122–64	1.611	1 39–64	103–64	0.145	9–64	9–64	2.68	8½	2⅜	415	3 7/16	2 9–32	2 1/16	⅜	71½
2	2.375	2⅜	152–64	2.067	2 1/16	132–64	0.154	5/32	10-64	3.61	9½	15½	700	4 7/16	2 11/16	2 1/16	1 1–32	132
2½	2.875	2⅞	184–64	2.468	2 15–32	158–64	0.204	13–64	13–64	5.94	10½	17⅜	1138	5 13/16	3 5/32	2 11/16	17–32	185
3	3.50	3½	224–64	3.067	3 1/16	196–64	0.217	7/32	14–64	7.54	13	19⅜	1885	4⅜	4 1–64	3	33–64	300
3½	4.00	4	256–64	3.548	3 35–64	227–64	0.266	7/32	14–64	9.00	15	21	2100	4	4½	2½	½	400
4	4.50	4½	288–64	4.026	4 1/16	258–64	0.237	15–64	15–64	10.66	16	32½	2160	4½	5 3–32	3½	½	412

Disadvantages of unlined conduit are: The unlined iron conduit may rust through; double braided conductors must be used in unlined conduit, to satisfy code rules; the increase in cost due to this requirement is slight, as compared with the greater cost of lined conduit and the cost of installing it.

Lined conduit is very seldom used at the present time with the exception that it sometimes finds appli-

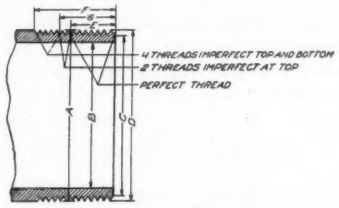
cation where every precaution must be taken to protect against trouble that might occur if the outer iron tube rusted through. Galvanized iron conduit should be used if conduit is installed out of doors. or in damp places, or where it is imbedded in cement.

As a general proposition, conduit wiring should be used whenever the job will stand the cost; ordinances of some cities now require that all concealed wiring shall be in iron conduit. It is probable that the method will, because of its inherent advantages, grow in popularity and will ultimately be almost universally used. Iron conduit effectively protects the conductors that it contains, and provides a smooth race-way, permitting the ready insertion or removal of conductors.

TABLE 2. STANDARD CONDUIT AND PIPE THREADS

BRIGGS FORMULA.

E= Perfect thread= (4.8+0.8 A)P. P= Pitch of thread= $\frac{1}{N}$ N= Number of threads. F= Length of Taper at top; taper $\frac{3}{4}$" to one foot; Height of thread= $8\frac{1}{N}$. G= Length of taper at bottom.



A= Outside diameter of perfect thread. B= Inside diameter of pipe C= Root diameter of thread at end of pipe. D= Outside diameter of thread at end of pipe. E= Length of perfect thread. F= Total length of thread. G= Length of perfect thread, plus two threads.

Size of Pipe	Numb. of Thd per in.	A	B	C	D	E	F	G	Dia. of Drill
⅛	27	.405	.270	.334	.393	.19	.41	.264	21–64
¼	18	.540	.364	.433	.522	.29	.62	.402	7/16
⅜	18	.675	.494	.567	.656	.30	.63	.408	9/16
½	14	.840	.623	.702	.816	.39	.82	.534	11/16
¾	14	1.050	.824	.911	1.025	.40	.83	.546	29-32
1	11½	1.315	1.048	1.144	1.283	.51	1.03	.683	1 5/32
1¼	11½	1.660	1.380	1.488	1.627	.54	1.06	.707	1 15–32
1½	11½	1.900	1.611	1.727	1.866	.55	1.07	.724	1 23–32
2	11½	2.375	2.067	2.200	2.339	.58	1.10	.757	2 7/32
2½	8	2.875	2.468	2.618	2.818	.89	1.64	1.138	2⅜
3	8	3.500	3.067	3.243	3.443	.95	1.70	1.200	3¼
3½	8	4.000	3.548	3.738	3.938	1.00	1.75	1.250	3 23–32
4	8	4.500	4.026	4.233	4.443	1.05	1.80	1.138	4¼

Electrical conduit is merely commercial standard weight wrought-iron pipe that has been carefully reamed inside to remove burrs and then treated with zinc, or an enamel, baked on, to prevent rust. The threads on the ends of conduit lengths are standard pipe threads; hence, where underwriters' inspectors do not have jurisdiction, iron pipe can be used instead of conduit. The pipe is cheaper, and in dry locations it appears to serve as well as conduit.

A coat of black stove-pipe enamel on the outside of the pipe will give it a finished appearance, and more than a superficial inspection is required to distinguish a pipe so treated from conduit. It is the practice in some industrial plants where the buildings are all of fireproof construction, and where no insurance is carried, to use galvanized-iron pipe instead of conduit.

Wire for use in unlined wrought-iron conduit must be double-braid, rubber-covered; single-braid wire is permitted in lined conduit. Each conductor must be continuous from outlet to outlet without splices or taps but the same conduit can contain as many as 4 2-wire or 3 3-wire circuits of the same system, and be in accordance with code rules. The same conduit must never contain circuits of different systems. Duplex wire, particularly No. 14, is largely used for branch circuits in conduit wiring; solid wire is used for conductors up to and including No. 6 but conductors larger than No. 6 are stranded so that they can be readily pulled into the ducts.

Where alternating-current circuits are in conduit, all of the wires of the circuit must be carried in the same conduit to prevent inductive voltage drop and dangerous overheating of the conduit.

Table I, gives dimensions of conduit, elbows and couplings. The diameters are given in decimals, common fractions and sixty-fourths for convenience, because there are times when the values are needed expressed in each of these ways. When figuring wire and wire insulation diameters, all values are usually expressed in sixty-fourths, which makes the sixty-fourths columns valuable for ready reference. The weight columns are convenient for estimating transportation charges; and from the values in the list price columns, the cost of the materials can be obtained by applying the discount that one receives; as an estimating discount, 50 per cent can be safely used. Dimensions of elbows and couplings are often used in laying out work on the drawing board, or in cases where clearances must be estimated in advance. Table 2 gives the dimensions of standard conduit threads.

(To be continued.)

SOME TIME AGO the president of a big public-service company found that the cost of small supplies was much higher than the actual quantities needed seemed to warrant. Investigation showed that men in repair and construction gangs were wasteful of bolts, screws, rods, wire, and like material, and careless about picking up small tools. Instead of blaming the men, the boss blamed himself.

"It is my fault," he said, "for I have never taken the trouble to let those fellows see what carelessness costs us. The yearly total as it comes to my desk is plain enough; but the repair man who loses a wrench or leaves half a dozen bolts lying in the road can't be expected to see that total. It's up to me to put the proposition to him clearly."

So average prices were set on each bit of material. Some of the little items, like bolts, cost only half a cent apiece, but the number that had been wasted every year ran into a good many dollars. To make it worth while to look after supplies, each gang was allotted a monthly quota sufficient to do its work without skimping. Records were then kept of all supplies issued to or returned by each gang, and all savings on this quota were credited, prizes being awarded to the gangs doing their work most economically. The scheme worked perfectly.—Saturday Evening Post.

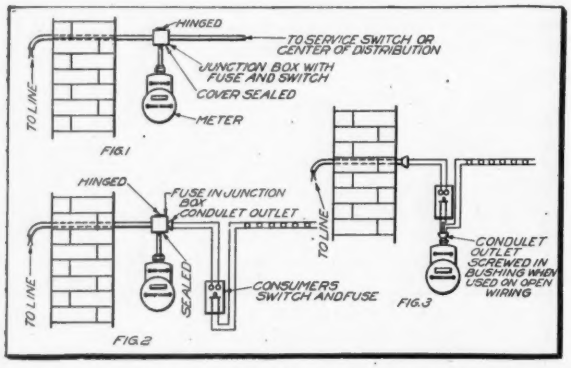
NAPOLEON SAID: "Get your principles right, then 'tis but a mere matter of details."

PROTECTION OF ELECTRIC METERS

Novel Devices to Prevent Theft of Current and Tampering with Meters

By Robert Montgomery

IN this electrical age, when almost every one has a smattering of electrical knowledge and every small boy is an amateur electrician, the unprotected meter is as impracticable for the central station as is the open cash drawer for the merchant. In a city of less than 100,000 population an inspection was made recently by one man who detected over 300 cases of theft during a period of three months. In 95 per cent of the cases a jumper of some kind was used, thus shunting out the series coil, or else the shunt wire to the meter



FIGS. 1, 2 AND 3. APPLICATION OF METER PROTECTORS TO VARIOUS CLASSES OF WIRING

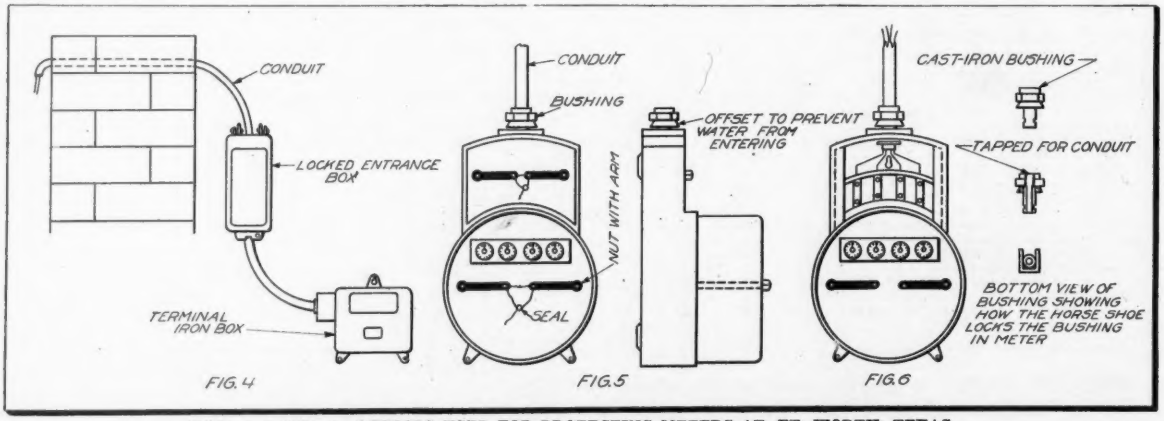
was disconnected. Only in a very few cases were holes drilled in the meters or hatpins forced through the cover or case of the meter.

Though a central station may be convinced that a customer is tampering with his meter, practically nothing can be done in the matter unless there is strong evidence. If there is evidence, in most cases the meter is either placed outside on a pole or else is protected by placing it in a steel cabinet, or in some other manner. There is much to be said against the practice of placing meters on poles, however, aside from the possibility of vibration caused by wind, etc., rendering meters inaccurate because of creeping. In such an attempt to safeguard its interests a company ignores the right of a customer to read his meter, which is not politic. The scheme is not to be commended, therefore, except in rare circumstances. In Fort Worth, Tex., use is made of the arrangement shown in Fig. 4. A small iron terminal box is fastened to the meter in such a manner that it cannot be removed without breaking the seals of the meter, and the entrance box containing the switch is also sealed. This method is very effective, and were it not for the cost and the difficulty of fastening the terminal box to the meter case it would be a very practical arrangement.

The meter manufacturers can furnish a solution to this problem with very little expense by providing every meter with a device for fastening to it a conduit and sealing it, and undoubtedly the first manufacturer who puts such a meter on the market will find it meet with much favor.

During the past year many experiments have been made at Fort Worth on devices of this kind. One plan is indicated in Figs. 5 and 6. A meter equipped with an outlet of this kind could be installed in houses already wired in conduit as is shown in Fig. 5. In cases where a residence or other building was wired with open wiring the meter could be arranged as shown in Fig. 2. In places where it was not necessary to protect the meter it could be installed as is shown in Fig. 3.

Referring to Fig. 6, it will be noticed that the arrangement is such that the cast-iron bushing can first be screwed on the conduit and the meter slipped over the bushing. Then the horseshoe device is placed over the bottom of the bushing, thus locking the meter to the bushing in such a manner that it cannot be removed unless the seals of the meter are broken. Another advantage is that the case of the meter would not be strained as it would be should the conduit be screwed directly into it.



FIGS. 4, 5 AND 6. DEVICES USED FOR PROTECTING METERS AT FT. WORTH, TEXAS

The idea of protecting a meter against theft of energy is not new. The device used at Fort Worth, however, differs from those already known to the electrical fraternity.—Electrical World.

Half of success is in seeing the significance of small things.

Your time belongs to your employer when he pays you for your work; then to "kill time" is robbery.—Electrician and Mechanic.

ELECTRICAL CORRESPONDENCE

FIELD EXCITATION AND THE POWER FACTOR

THREE alternators furnish power to a system, the power factor of which is 60. Will it take more field current for the generators when running with a power factor of 60 than with power factor of 95?

If the generators are connected to a low power factor system, and 2 of them don't have their fields properly balanced, but the third has the proper amount of field current for the load it is carrying, what will be the effect on each individual generator? A. B. S.

A. In regard to the operation of your system, the same amount of field excitation will be required to give a certain voltage at the terminals of the armature, whether the power factor of the circuit is 60 or 95, but in order to produce a given current in the circuit the excitation must be much higher when the power factor is 60 than when it is 95.

So far as the operation of the 3 generators in parallel is concerned, if the field is under-excited the machine will take less than its proper amount of load, while the one which is properly excited will take its normal share of load and if any one of the machines is over-excited it will take more than its proper share of the load.

A. L. R.

CONSTRUCTION OF OIL SWITCHES

GIVE an explanation of the construction, operation and the reasons for using oil switches on high tension circuits. L. S.

A. When breaking a high tension circuit with an open air switch severe oscillations of voltage are set up in the line and are dangerous to insulation. An arc is maintained for some seconds across the switch terminals which emits metallic vapors and soon destroys the terminals.

It has been found that an oil switch obviates all these effects.

Oil switches are hand, solenoid, or motor operated. Various makers employ distinctive methods of operation and construction but in all cases the entire switch is immersed in oil. In the larger sizes the whole apparatus is set in a concrete or brick pit. Spring terminals opening downwards are stationary in the oil bath. Operating from above is a rod or plunger which passes down between the terminals. Fastened on the end of the rod is a metallic cross piece with a tapered lug at each end. When the rod is raised or lowered the lugs enter or leave the spring terminals making or breaking the circuit.

E. C. H.

STORAGE BATTERY PROBLEM

J. L. R. wishes the opinion of readers in regard to the use of storage batteries to carry his night load of 40 32-candle power lamps. The method suggested of installing a small generator to be used during the day time to carry the day load, and recharge the batteries would work all right, in which case it would not be necessary to run the generator at night. The load would be about 37 amperes, and a small battery outfit would carry it in good shape.

Some years ago I had charge of a plant that was operated 18 hr. a day, the load from midnight to 6 a.m., which was from 75 to 100 amperes was carried by the batteries. The batteries were charged during the day by a motor-generator set which took current from the bus-bars. This outfit was used several years or until the night load increased to such a point that it was necessary to run the generator all night.

If he has to run his generator at night it would be much cheaper to supply current to the lights direct from the generator, for the reason that if he uses batteries there will be quite a large loss in power from the generator through the booster to the batteries and through them to the lamps so that he would have to generate more than 37 amperes to supply a 37-ampere load through the batteries. Then if his generator must run at night it would greatly reduce the cost of the plant to leave the battery outfit out and supply the current direct from the generator. They require quite a lot of attention and some expense for upkeep. In the plant with which I was connected the load on the generator during the day was such that the batteries could be easily carried except during the peak load period. This gave us a higher load factor during the day, and during the time from midnight to morning when the load was reduced to a few lights, the fires were banked and the engines shut down, and the load carried by the batteries. There was no one on duty during this 6-hr. period.

If his requirements are such that running the generator all night will entail very much extra expense he would find storage batteries a very good method of carrying the night lighting load.

J. C. Hawkins.

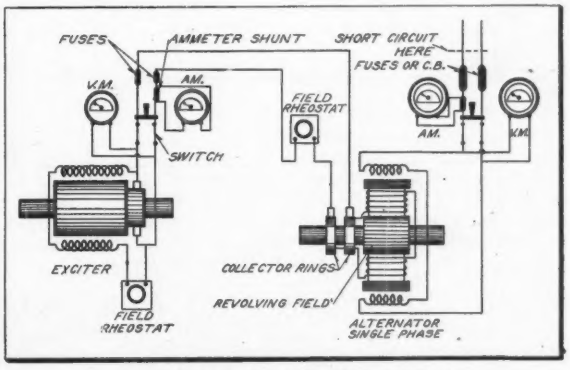
ALTERNATOR CONNECTIONS

PLEASE give me directions for connecting an alternator and drying it out. V. H.

A. Accompanying sketch shows the connections of a single-phase alternating-current generator of the revolving field type.

You do not state in your letter what type of machine it is, but the general scheme of the connections and the directions for drying out will apply to single, 2 or 3-phase machines, also to revolving armature machines.

To dry out the alternator, either run it at a low speed with the fields fully excited and with the terminals



ALTERNATOR CONNECTION DIAGRAM

short circuited, so that it does not carry more than normal load, or it may be run at normal speed with the field excitation quite low.

Thermometers should be applied to the armature winding at various points, and the temperature should not exceed, at any time, 212 deg. F. in the various parts.

The length of time which the drying out process will require depends entirely on how damp the machine was when started, and it will depend much on the judgment of the operator. N. G. M.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Installation of Large Pelton Wheels, Temperature of Gas Engine Cylinders, Centrifugal Pump Tests

By J. H. Blakey

A PELTON wheel of 20,000 hp. has been constructed by the Esscher Wyss Cie. of Zurich, Switzerland, for the Electrical Society of Rio Janiero. The society had previously 6 turbines of 9000 hp. each, so that the addition of 2 Pelton wheels of 20,000 hp. brings its total up to nearly 100,000 hp.

These new wheels are tangential to the vertical axis, and are fed by 4 injections. They work under a head of water of 286 m. (930 ft.) at a velocity of

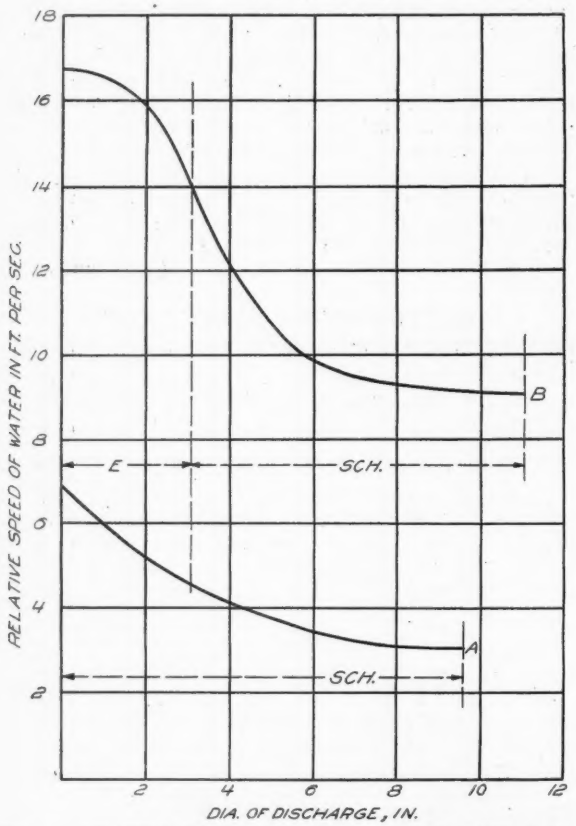


FIG. 1. RELATIVE SPEED OF WATER IN WHEEL WITH MAXIMUM DISCHARGE: A. MATHER-REYNOLDS PUMP OF 1895. B. MODERN HIGH-PRESSURE PUMP

300 r.p.m. with a discharge of 6200 cu. m. (218,000 cu. ft.) a second. The water is brought to the vanes by 4 nozzles branching from the main supply pipe, which encircles the wheel and decreases in diameter as each nozzle is given off. These 4 nozzles are controlled by steering engines, one for each; the steering engines are commanded by the speed regulator, which is similar to the ordinary pendulum governor in use on steam engines.

At the entrance of the main supply pipe is a large sluice valve actuated by a hydraulic steering gear. The oil required by the different parts of the turbine is supplied under pressure by 2 3-cylinder high-pressure pumps, each one driven by small special turbine and delivering 360 liters (95 gal.) a minute. One pump only is in use, the other being for use in case of an emergency. The large bearing between the turbine and the generator is a thrust block which alone carries the weight of these 2 parts, which amounts to 76 tons. Hence the need of lubrication at high pressure. The bearing below the turbine is simply a guiding pivot, and does not carry any weight. It is lubricated by the same system, and its dimensions have been calculated to give a large margin of safety, as, being covered by the discharge water, it is inaccessible while the turbine is in action.

The main which brings the water to the turbine is 1250 mm. (4 ft. 2 in. nearly) in diameter, and it is furnished with air chambers to guard against hydraulic recoil. The total height of the structural work supporting the turbine and generator is 26 ft., its breadth 24 ft. and its length 41 ft. The diameter of the wheel is 12 ft. and of the vertical shaft, 16½ in.

Cylinder Temperature of Gas Motors and Its Influence upon Efficiency

IF any gas engine is submitted to a test and the result is studied, it will be found that there exists a mean pressure in the cylinder which differs widely from that to be arrived at from a theoretical calculation. This mean pressure depends naturally very much upon the calorific power of the gas. This, in relation to weight for given volume, is smaller for a lower density of equal volume. With a total

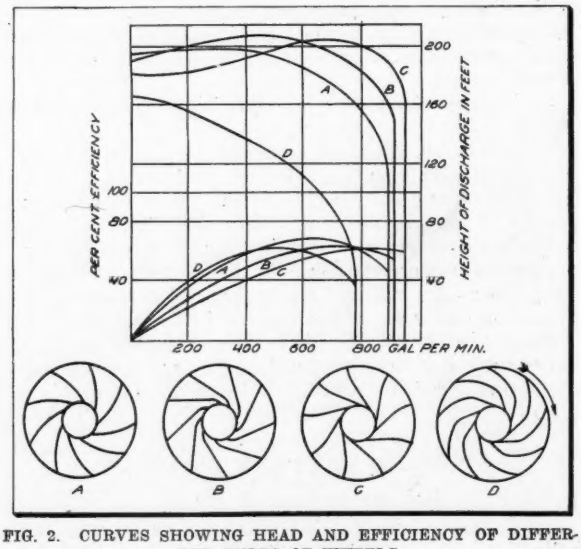


FIG. 2. CURVES SHOWING HEAD AND EFFICIENCY OF DIFFERENT TYPES OF WHEELS

smaller calorific power, the efficiency must therefore be reduced. The question of efficiency then presents itself as the difference of temperature of the gases at the moments of entry and escape.

Suppose, for example, that the gases in the combustion chamber or at the escape have a temperature of 1000 deg. C. If the temperature of the gaseous mixture introduced is 25 deg. C. the difference of 975 deg. determines the value of the energy furnished. The effect is here much greater than if the temperature of the entering gases had been 100 deg. But the

effective power is higher in the second case than in the first, because the burnt gases contained in the cylinder or at the escape have been submitted to a higher range of temperature.

At the moment of the closing of the escape valve, the gas at the end of the cylinder has a pressure of about 25 kg. a square centimeter (355 lb. a square inch). Before the new charge can enter under atmospheric pressure it is necessary that this residual gas be expanded until below this pressure; and in considering this the volume occupied by the piston must be taken into account.

Even when the new charge is at a temperature of 25 deg. and the residual gases at 900 deg. their mixture cannot modify the real volume, but it can change the conditions of density. If the temperature of the mixture at the end of the aspiration stroke is about 80 deg., the weights of the gases must then be in proportion to the absolute temperatures, and it is necessary for this reason to take into account a new increase of the volume occupied by the piston, if it is desired to obtain in the result the primitive theoretical value.

It can therefore be said in general that when theoretical calculations have given a relation of pressure of 4 to 1, the motor may be considered as having an actual pressure relation of 5 to 1.

Even if a motor is studied in a way that will satisfy theoretical conditions, the result from the point of view of power depends always upon the temperature of the cylinder. It is sufficient to observe the exterior temperature of the cylinder walls or the variation of temperature of the circulation water. The truth of this assertion can be easily proven. If it were possible, for instance, to maintain the walls of the cylinder or the circulation water at 25 deg. C. (77 deg. F.) the maximum power of the gas would be obtained. But that is not possible, as the water has on leaving the cylinder 3 times the temperature it had on reaching it, or about 50 deg. C.

If the thermal capacity of the gas is 0.83 (that is, if it requires 0.83 of a unit of heat to raise the temperature of 1 kg. of the gas 1 deg. C.—the unit being the amount of heat required to raise the same amount of water 1 deg. C.), and if the weight of the charge is 1/12, then it requires 1/12 of 0.83 or 0.069 of a unit to obtain the same result, and we have $50 \times 0.069 = 3.45$ units of heat which do not contribute to the production of force.

The more the temperature of the water is raised, that is the greater is the difference of the temperatures at entrance and exit, the greater is the heat loss per unit of weight of gas; and the higher the temperature of the walls of the cylinder, the more feeble is the force developed by the gaseous charge.— Die Gasmotorentechnic.

Development of the Centrifugal Pump and Its Present Status

THE first suggestion for a multicellular pump was made by John Gwynne, who, in a patent taken out in 1851, described a reaction wheel which was practically the same as some of those in use today. In 1875 Osborne Reynolds invented a turbine pump with wheels arranged in series, and having directing vanes. This construction, after having been variously modified, has culminated in the Mather-Reynolds type of 1895, which will be taken as a standard of comparison for more recent pumps. In the construction of 1895 the mean speed of the water in the wheels and in the directing vanes was relatively feeble, and it was consequently necessary to have large sections.

Until 1904, the house of Sulzer Brothers of Winterthur, Switzerland, worked in common with Mather of Manchester, England, and made considerable advances in the construction of centrifugal pumps, using the original Reynolds pump as a model. Since 1904 these firms have worked independently.

The modern Sulzer pump presents 3 improvements upon the pump of 1895: 1. The casing is in a single piece, into which the diaphragms, vanes and wheels are introduced by one of the sides. 2. The wheels are closed and have backward curved vanes. 3. The wheels are arranged back to back in pairs, which compensates the axial thrust and renders unnecessary any special device to take care of this.

The 4-stage Mather and Reynolds pump differs from the preceding in having a shorter aspiration side, which facilitates the attachment to the motor, either by means of a coupling or a pulley. The cells are held together by long bolts which extend the whole length of the casing. This arrangement, besides avoiding internal strain, also lowers the cost of manufacture. The directing vanes are longer and have a more correct spacing. The axial thrust is absorbed by a device which gives very good results.

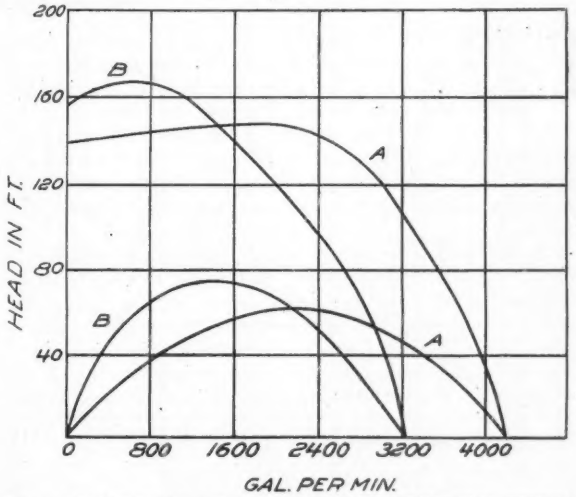


FIG. 3. TOTAL HEAD AND CAPACITY OF CENTRIFUGAL PUMPS: A. MATHER-REYNOLDS PUMP OF 1885. B. MODERN HIGH-PRESSURE PUMP. SPEED 600 R.P.M.

The installation of centrifugal pumps at the station of St. Gabrielle of the Montreal Water and Power Co. is especially worthy of notice. This installation was built by Mather and Platt in 1904. The pumps are driven, direct connected, by a Zoelly turbine of 1800 hp. Each pump delivers 1680 cu. ft. (10,500 British gal.) of water a minute, against a head of 410 ft. when running at 1500 r.p.m. The pump has 2 impellers working in parallel, that is both impellers receive water from the suction pipe and deliver it to a common discharge. The water enters the suction pipe under a head of 10 ft. and flows into the middle of the casing, then it divides into 4 streams entering on both sides of each impeller. With this arrangement no axial thrust can be produced.

Mather and Platt constructed in 1911, for the draining of a mine, a pump still more powerful than that described above. It has a discharge of 3000 gal. a minute against a head of 2000 ft. It will be noticed

that although the discharge of this pump is smaller than that of the pump just described, its lift is considerably greater. The pump is coupled directly to a 3-phase motor of 2500 v. and 1900 hp. running at 1450 r.p.m. It is composed of 7 wheels in series, of phosphor bronze, keyed upon a shaft of large diameter. The vanes are heavy castings of a special bronze in a single piece, fitted into the cast-iron diaphragms. There is only one bearing inside the casing, which is at the discharge end. The other bearing is bolted onto the foundation plate of the pump and supports the end of the shaft which projects from the aspiration end of the casing.

The accompanying diagrams show graphically the result of recent experiments with centrifugal pumps. Figure 1 shows the comparative speed of the water in the Mather-Reynolds pump of 1895 and in the modern high-pressure large discharge pumps. It will be noticed that the speed is almost three times as great in the modern pump. Figure 2 indicates the efficiencies and the height of head given by 4 different forms of wheels, all of which have recurved vanes.

The form C is nearest to that of Reynolds, while the form A is almost identical with that of the modern pump. The wheel D gives a progressive fall of curve for the height of head as the discharge increases; the amount of power absorbed becomes greater, and the efficiency diminishes. Figure 3 gives the efficiency and discharge of a modern pump compared with the Reynolds pump of 1895. The difference in efficiency depends entirely upon the form of the wheel and directing vanes, which are too short in the Reynolds pump.

The diagrams indicate that when the height of the head is of primary importance, the form B, Fig. 2, will give best results; when the volume of discharge is the first consideration, the form C should be used.

It will be noticed also that wheels A, B and C, have each a maximum efficiency of about 75 per cent, C, however, reaching its highest efficiency at a larger discharge than A or B. The highest efficiency of D, about 70 per cent, is reached at a discharge of about 500 gal. a minute.—Die Turbine.

PRACTICAL MATHEMATICS

Problems in Weights and Pulleys, Windlasses, Inclined Planes and Gearing, Solved by Formulas, Logarithms and the Slide Rule

FIGURE 1 shows a single pulley, suspended from the ceiling, over which runs a rope attached to a weight W. It is evident that to hold the weight suspended, the force P must be equal to the weight; that is, if the weight is 10 lb., the downward pull on the opposite part of the rope to that which the weight is attached, must be 10 lb., furthermore, the weight and the force must travel through equal distances.

If the arrangement of weight and pulley shown in Fig. 2 is used, a given force will raise a weight twice as great as the arrangement shown in Fig. 1, as one part of the rope is supported by the ceiling, therefore the sustaining force supports but half the weight. We have another condition to consider, to raise the weight 1 ft. the force must move 2 ft.; in other words,

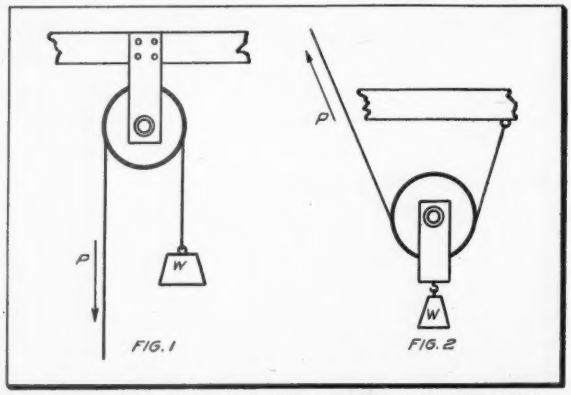


FIG. 1. SIMPLE PULLEY WITH POWER AND WEIGHT BALANCED

FIG. 2. PULLEY AND WEIGHT SUPPORTED BY ROPE ATTACHED TO CEILING AT ONE END AND SUSTAINED BY POWER AT THE OTHER END

we have used only half the force, but it has moved twice as far, therefore, the foot-pounds of work required for moving equal weights equal distances is the same in both Figs. 1 and 2.

In Fig. 3 there is a combination of the conditions existing in both Figs. 1 and 2. The pulley D serves only as a convenient means for permitting the force to move in a downward direction, illustrated by a man standing on the floor and pulling on the rope. It is evident then that pulley D corresponds to that in Fig. 1. The pulleys A, B and C each correspond to Fig. 2.

In the combination of pulleys, shown in Fig. 3, 1 lb. pull will raise a weight equal to 2 multiplied by

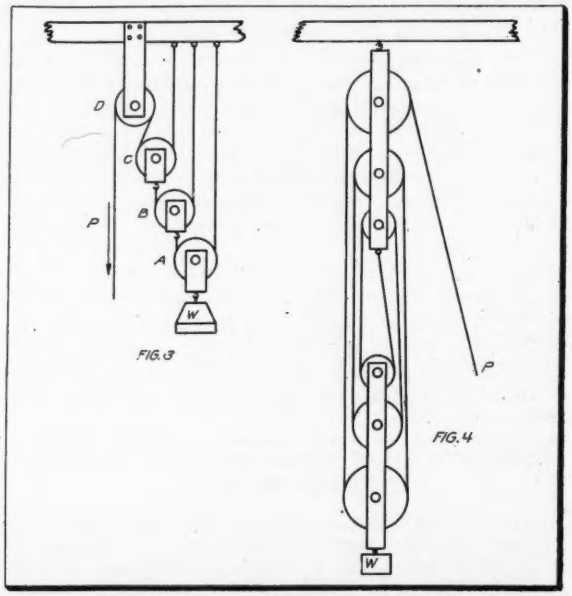


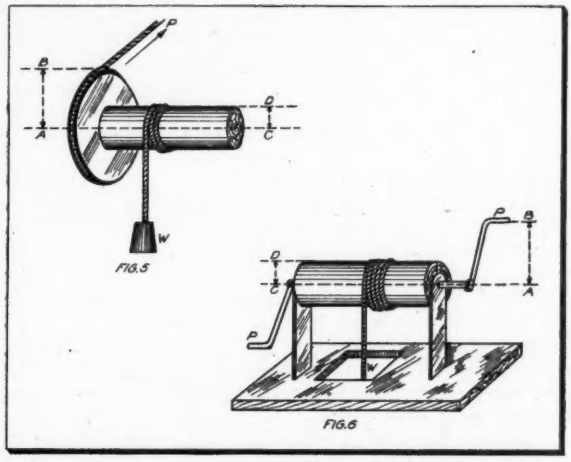
FIG. 3. SYSTEM OF PULLEYS WITH 3 MOVABLE BLOCKS
FIG. 4. PULLEY BLOCKS AND WEIGHT

itself as many times as there are movable pulleys (in this case 3 times). This example can be expressed by the proportion $P : W :: 1 : 2 \times 2 \times 2$. If the weight is 50 lb., how much force will it take to raise it? The

proportion will then read P: 50 :: 1 : 8; multiplying the means and dividing by the extreme gives P, 6¼ lb.

Let us assume that the weight is 38 lb. and there are 5 pulleys; then the problem will read P: 38 :: 1 : 2 × 2 × 2 × 2 × 2. We evidently have to raise 2 to the fifth power or multiply it by itself 5 times, giving 32. Dividing 38 by 32 gives 1.18 lb. as the force required.

In the system of pulleys shown in Fig. 4, a given force will raise a weight as many times greater than



FIGS. 5 and 6. TWO TYPES OF WINDLASSES

itself as there are parts of the rope running through the movable block or P = W ÷ N. In this problem assume the weight to be 185.5 lb.; the number of parts of the rope is 6, then P = 185.5 ÷ 6 = 30.9 lb. To solve on the slide rule, place 6 on C scale over 185.5 on D scale and under 1 on C read 30.9 on D scale, which is 30.9 lb. force.

We must still remember that there is no gain in work, as the weight travels a distance inversely proportional to the distance traveled by the force and the product of distance times weight is equal to the product of distance times force.

Windlasses

FIGURES 5 and 6 show 2 forms of a windlass; in each type a given force will raise a weight as many times greater than itself as the radius A B of the force

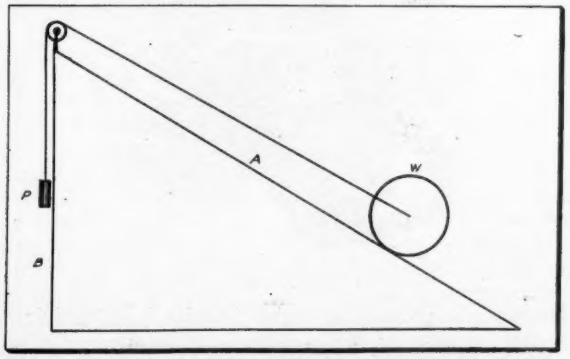


FIG. 7. GRAPHIC ILLUSTRATION OF AN INCLINED PLANE

arm or wheel is greater than the radius C D of the weight spindle or drum over which the rope winds. If the radius A B is 36 in. and the radius C D 12 in., what power will be required to raise a weight of 175 lb.? This is an example in simple proportion and can be expressed P : 175 :: 12 : 36 or P = 58.33 lb.

To perform the operation on the slide rule, place 36 on the left-hand B scale under 12 on left-hand A scale; over 175 on right-hand B scale find 58.33 lb. on left-hand A scale.

To find the decimal place, express the operation with approximate numbers P × 36 = 175 × 12; P = 175 × 12 ÷ 36 or, approximately P = 180 × 12/36 and 12 in 36 = 3; and 3 in 180 = 60, hence the answer is 58.33 lb.

Inclined Planes

IN Fig. 7 is shown a graphic illustration of an inclined plane. Assume that the plane A is a track leading from the scrap pile to the charging room of a foundry cupola. Let W represent a car loaded with scrap iron weighing 1000 lb. Neglecting friction, what horsepower will be required to pull the car up the incline in one minute, if the incline is 100 ft. long and 50 ft. high at the upper end?

By the rules of mechanics, a given power acting parallel to the plane will support a weight as many times greater than itself as the length A, of the plane, is times greater than its vertical height B, or P : W ::

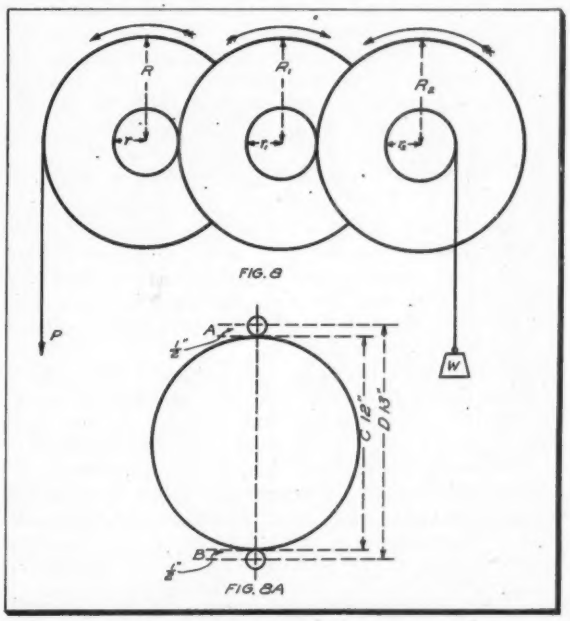


FIG. 8. SYSTEM OF GEARS AND PINIONS

FIG. 8-A. DIMENSIONS OF DRUM AND CABLE TO FIND SPEED OF DRUM

B : A, in this example A is 100 ft. and B 50 ft., then P : 1000 :: 50 : 100. Multiplying the means and dividing by one extreme, P = 500 lb., the force required to hold W in equilibrium.

Let us replace the weight P with a hoisting engine. The pull required is 500 lb., and the distance traveled in one minute is 100 ft. As one hp. equals 33,000 ft. lb. per min., the power required to operate the car loaded is $\frac{100 \times 500}{33{,}000} = 1.51$ hp.

To solve the problem on the slide rule, place 33 on C scale over 500 on D scale and under 1 on C read 1.51+ on D.

Gearing

TOOTHED wheel gearing is a combination of 2 or more wheels and axles, as shown in Fig. 8. If a series of wheels and pinions gear into each other, as shown in the figure, friction neglected, the weight lifted or force overcome is to the force applied inversely as the distance through which they act in a given time.

If R, R_1 and R_2 are the radii of the successive wheels, measured at the pitch line, r, r_1 and r_2 the radii of the pinions, then $P:W::r \times r_1 \times r_2 : R \times R_1 \times R_2$. What force would be required to raise a weight of 50 lb. if each small radius is 3 in. and each large radius 12 in.? Our example would then read $P:50::3 \times 3 \times 3 : 12 \times 12 \times 12$.

The second mean of the proportion, $3 \times 3 \times 3 = 27$ can be calculated mentally, but logs. can be used to advantage for finding the product in the second extreme. Refer to the table of logs. and find in column 0, opposite 12, 0.0792 the mantissa; as the characteristic is one less than the number of places to the left of the decimal point it is obviously 1, then log. $12 = 1.0792$.

$$1.0792 \times 3 = 3.2376 = \log. 12^3.$$

We find the next mantissa smaller, in column 2 opposite 17, the latter being the first 2 figures of the desired number, and as the nearest mantissa is in column 2, 2 is the third figure. The difference between the nearest mantissa and the mantissa in the problem, is 21. In the supplementary table, we find that 20 in column 8 is the nearest number to the difference, so the fourth figure is 8, giving 1728 as the required number.

Substituting the new figures in the proportion, we have $P:50::27:1728$; or $P = 50 \times 27 \div 1728$.

From the log. tables we find that log. $50 = 1.6990$; log. $27 = 1.4314$; log. $1728 = 3.2376$. Adding 2 logs. gives the log. corresponding to the product; subtracting one log. from another gives the log. of the quotient from dividing the first number by the second; hence, our problem will now read log. $P = (1.6990 + 1.4314) - 3.2376$. $1.6990 + 1.4314 = 3.1304$. As the subtrahend is greater than the minuend, we add 10 to the characteristic of the latter and subtract it also, indicating it by writing —10 after the log., thus, $13.2376 - 10$. Adding a number to, then subtracting it from a second number does not change the value of the latter. So we have: $(13.1304 - 10) - 3.2376 = 9.8928 - 10$.

We know that the mantissa is always positive, therefore 10 must be subtracted from the characteristic of the remainder only, giving $\overline{1}.8928$. By simple arithmetic we cannot subtract a larger from a smaller number, but this operation can be indicated by using a negative or minus sign. For example, if a man owns as his only asset, a steam engine worth $1000, and owes $2000, we indicate the asset by +1000 and the liabilities by —2000; then $+1000 - 2000 = -1000$ or in other words, the man owns $1000 less than nothing, or owes $1000 net. In like manner $9 - 10 = -1$ or as usually written $\overline{1}$, which was explained in the Dec. 15, 1912 issue.

Looking for mantissa 8928, in column 1 opposite 78, we find 8927 the next smaller mantissa, then 78 are the first 2 figures and 1 is the third figure. The difference between the 2 mantissae is 1, therefore the fourth figure, 2, is found at the head of the column of supplementary numbers over the second 1 on the line with 78. As the characteristic is —1, the answer to our problem is 0.7812 lb., the required force.

As a practical application of this problem let us apply it to a hoist such as might be used to draw a car up an incline and refer to the problem under inclined planes where we found that it required 1.5+ hp. to draw a carload of scrap iron up an incline in 1 min. The car traveled at the rate of 100 ft. a minute. Let r_2 represent the cable drum of the hoist, which we will assume is 12 in. in diameter and the cable 1 in. in diameter. First determine at what speed the drum must revolve to draw the car 100 ft. a minute. It is necessary to ascertain the circumference of the drum which must include the radii of the cable, as shown in Fig. 8a, where A and B represent the radii of the cable, C the diameter of the cable drum, and D the required diameter.

Circumference of drum $= 13 \times 3.1416 = 40.8$ in. $40.8 \div 12 = 3.4$ ft. Required number of revolutions of drum a minute $= 100 \div 3.4 = 29.7$.

To perform the operation on the slide rule, set the left-hand index of the slide rule under the mark on A, indicating 3.1416, and over 13 on B scale find 40.8 on A scale, then divide 40.7 by 12, to reduce the circumference to feet, by placing 12 on B scale under runner, 40.7 on A scale and over index find 3.4 ft. on A scale. To find the required number of revolutions of the drum a minute, divide 100 by 3.4 by placing 3.4 on C scale over 100 on D scale and under index find 29.7, the required number of revolutions of the drum per minute.

Let the large gear attached to the drum be 24 in. in diameter, then $R_2 = 12$ in. Let $R_1 = 12$ in., r_1 2 in. and r, which we assume to be a motor pinion, 2 in. Then the required speed of the motor will be $S:29.7::$

$$R_1 \times R_2 : r \times r_1 = \frac{29.7 \times 144}{} = 1069 \text{ r.p.m.}$$

VACUUM BREAKERS

By William E. Dixon

ON page 142 of Practical Engineer for Jan. 15, G. H. Wallace makes some remarks in reply to some questions on the above subject. These remarks leave so much unsaid upon the matter that the writer feels impelled to add something.

In the first place there are 2 distinct types of vacuum breakers. One of these is placed directly in or upon the condenser chamber and is operated by a rise of water in that chamber above a predetermined level. Its sole purpose is to protect the engine cylinder from receiving a "dose" of water. The other type may be attached at any point between condenser and engine and is operated electrically or mechanically in connection with an engine stop system. Its primary purpose is to assist in quickly checking overspeed of the engine; but under certain conditions it would act also in the same way as the first type.

FIG. 2. VACUUM BREAKER FOR USE ON EXHAUST LINE BETWEEN ENGINE AND CONDENSER

The first type is shown in elementary form in Fig. 1. A is a valve opening into condenser chamber. Normally, it is held closed because pressure upon it is greater than the pressure under it. If, however, water rises to level of C, the float B rises enough to overcome atmospheric pressure and open the valve. In actual practice the result is accomplished in a less direct but more positive way. There are several methods of doing this; but these need not be gone into here. The above illustrates the principle and that is sufficient for this discussion.

An example of the second type is shown in Figs. 2 and 3. In Fig. 3 the breaker is screwed into the condenser at A. B is the valve and is held, normally, to its seat by atmospheric pressure. Whenever circuit is closed and breaker is tripped, passage I is opened and air exhausted from H, through I and J. Piston K being larger than valve B, the latter is raised and air enters condenser.

It ought not to be necessary to go more fully into the operation of the vacuum breaker. And yet it seems

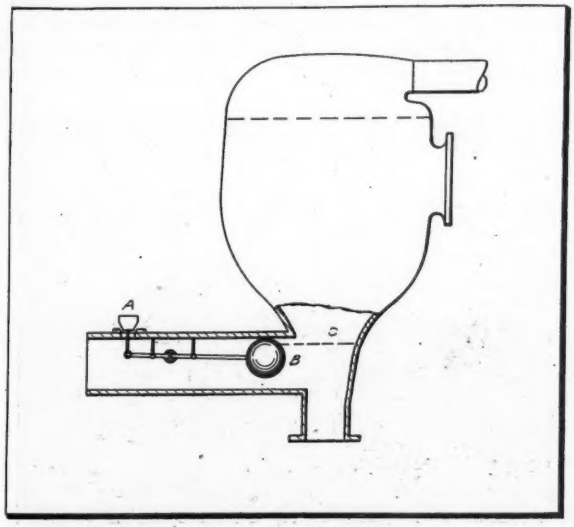


FIG. 1. DIAGRAM OF VACUUM BREAKER USED ON THE CONDENSER CHAMBER

to be advisable. There are not a few men who imagine that the valve "lets the vacuum out." And there are many more who mix its action up in some mysterious way with that of the atmospheric relief valve. So let us try to straighten things out.

The condenser maintains a vacuum because of the fact that steam brought into contact with cold water (or cold anything else for that matter), condenses into water and in so doing takes up but a small fraction of the space which it has just been occupying. Now it is possible to condense air. All we need to do is to subject it to considerable pressure and to a temperature of a few hundred degrees below zero. But this is too troublesome and expensive an operation to be considered in the engine room and so we simply condense our steam in the condenser and get rid of the small quantity of air in it, in a different way. Now the method of doing this will take care of a little air and only a little. When we open a valve and let in a good supply of air the pump gets air bound, and if the injection water is lifted the injection pipe fills with air and the vacuum is gone. Then the relief valve comes into play. The engine continues to put steam into the condenser and it doesn't condense; the pressure rises and so does the relief valve. But if a vacuum exists in the cylinder, air instead of water fills it.

Mr. Wallace says: "In any event, should this failure occur, open the vacuum breaker at once and let the engine run and exhaust to the atmosphere." Mr. Wallace's understanding may not be cloudy; but his expression is; and his advice, also, is wrong. Instead of opening a vacuum breaker, shut the exhaust valve; the engine will then exhaust to atmosphere without any "letting" on your part.

Now the vacuum breaker accomplishes its purpose by flooding the condenser with air. Next, why is a vacuum breaker needed? The answer is that it isn't always—only sometimes. Let us take one of those times. Suppose a man shuts the throttle on an engine, then walks over and shuts the throttle of the condenser air pump, then folds his arms and looks around. It has been done, probably will be done again. What happened next —supposing the engineer bought a condenser minus a

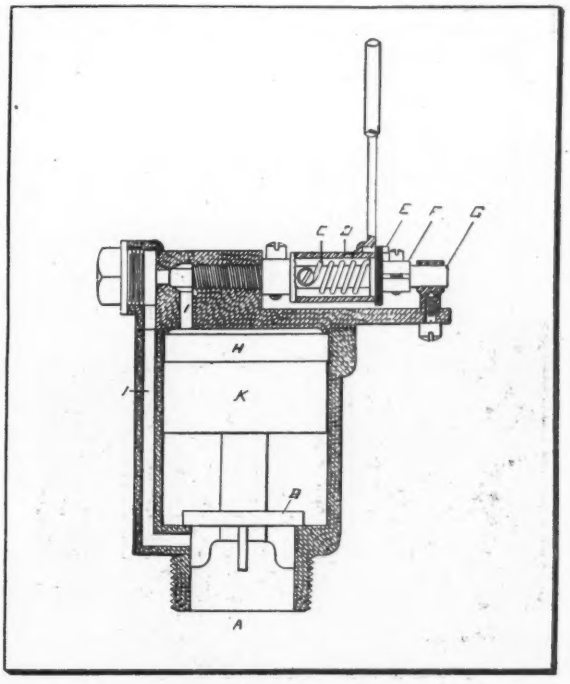


FIG. 3. CROSS-SECTION OF VACUUM BREAKER

vacuum breaker? Well, that engine has been pumping steam out of the boilers all day. Suddenly the supply is shut off. The engine gets nothing, but it continues to pump. And if you pump nothing for a short time, real energetically, you soon get a beautiful vacuum. There has been a vacuum in the condenser but that is gone—filled with water by Mr. Atmospheric Pressure out on the pond. The exhaust valve opens and Mr. A. P. pushes a big drink into the cylinder. We won't let that happen again of course—so we'll put on a vacuum breaker.

Suppose, however, we have a surface condenser. Never any water there. Injection can't get into the cylinder. That is one of the places I meant when I said "sometimes." How about a barometric? Need one there?—Talking, all this time, about a breaker of the first type. The second type is appropriate for use with any sort of condenser.

Let us consider, a moment, the hand operated breaker. It is of course better than nothing—sometimes. But an

air pump may stop any minute and no engineer has time to sit watching that all day.

The writer also must question Mr. Wallace's statement that a vacuum breaker is necessary to prevent compound engines from starting. How about the exhaust valve? If that is closed how can condenser act? What is the use of hammering an air pump along sucking air in through a useless opening? Moreover, the writer for a long time operated large engines exhausting into a common condensing circuit and these engines were not shut off from the condenser except when making repairs. They drove generators and therefore were shut down with the load off. And no load could be put on until they were up to speed. Yet these engines would come to full stop in less than a minute after shutting throttle and would remain stopped. If a pumping engine with load on will operate slowly under such condition, I should say the throttle needed some attention.

He also states: "In fact, in this type of unit, with independent air pump and condenser, the pump would continue to operate slowly, indefinitely after closing the throttle, unless the vacuum breaker were opened or the air pump stopped." Let us see, with the steam valve closed the pressure on each side of the piston soon becomes a vacuum equal to that in the condenser and without unequal pressure the engine can not run.

THE PANAMA CANAL

Safety Gates or Emergency Dams for the Gatun and Pedro Miguel Locks

By A. P. Connor

THE safety fender chain which is used in the Panama Canal Locks is a means for preventing the majority of accidents anticipated by the engineers of this great undertaking, that are apt to affect materially the operation of the locks. In view, however, of unexpected accidents, and such extraordinary ones as the demolishment of the lock gates by any means, or the breaking of the machinery that holds the gates in their positions. Such accidents have happened in some of the important canals in this country, and have been productive of serious harm. In the case of the Panama Canal such an accident might put it out of operation for 2 yr. To prevent such a serious state of affairs it was considered essential to provide safety gates for the canal, and these safety gates are officially known as "the emergency dams." These gates or dams are normally kept on a large turntable bridge and are dropped into the locks when necessary to keep the water from escaping from the lakes through the locks. They may, for instance, also be used to shut off water from the locks so that repairs may be made, and other incidental uses.

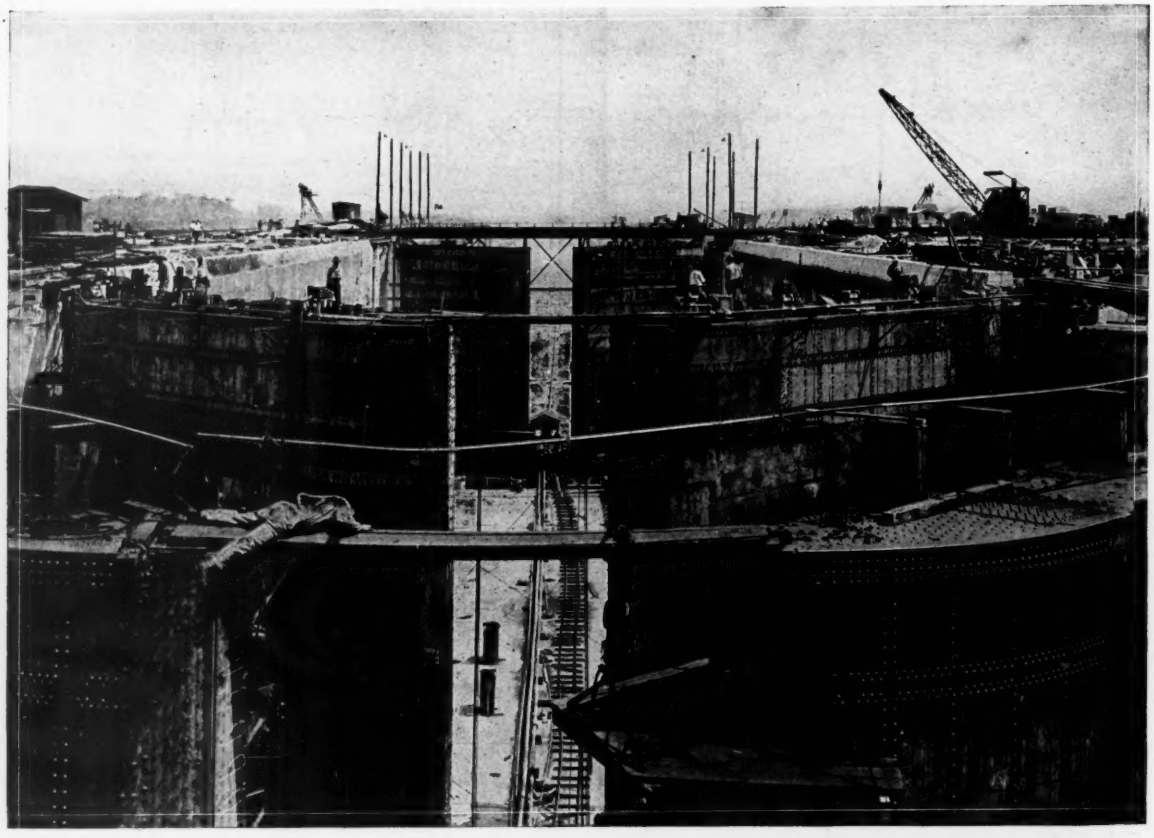


FIG. 2. GATUN UPPER LOCKS, WEST CHAMBER, LOOKING NORTH FROM SOUTH END, SHOWING CONSTRUCTION OF 3 SETS OF GATES, MARCH 12, 1912

In a former article a reference was made to the size of the lock gates and from that description an appreciation of their tremendousness could be obtained; and when it is realized that the safety gates or emergency dams must perform a similar function to that of the

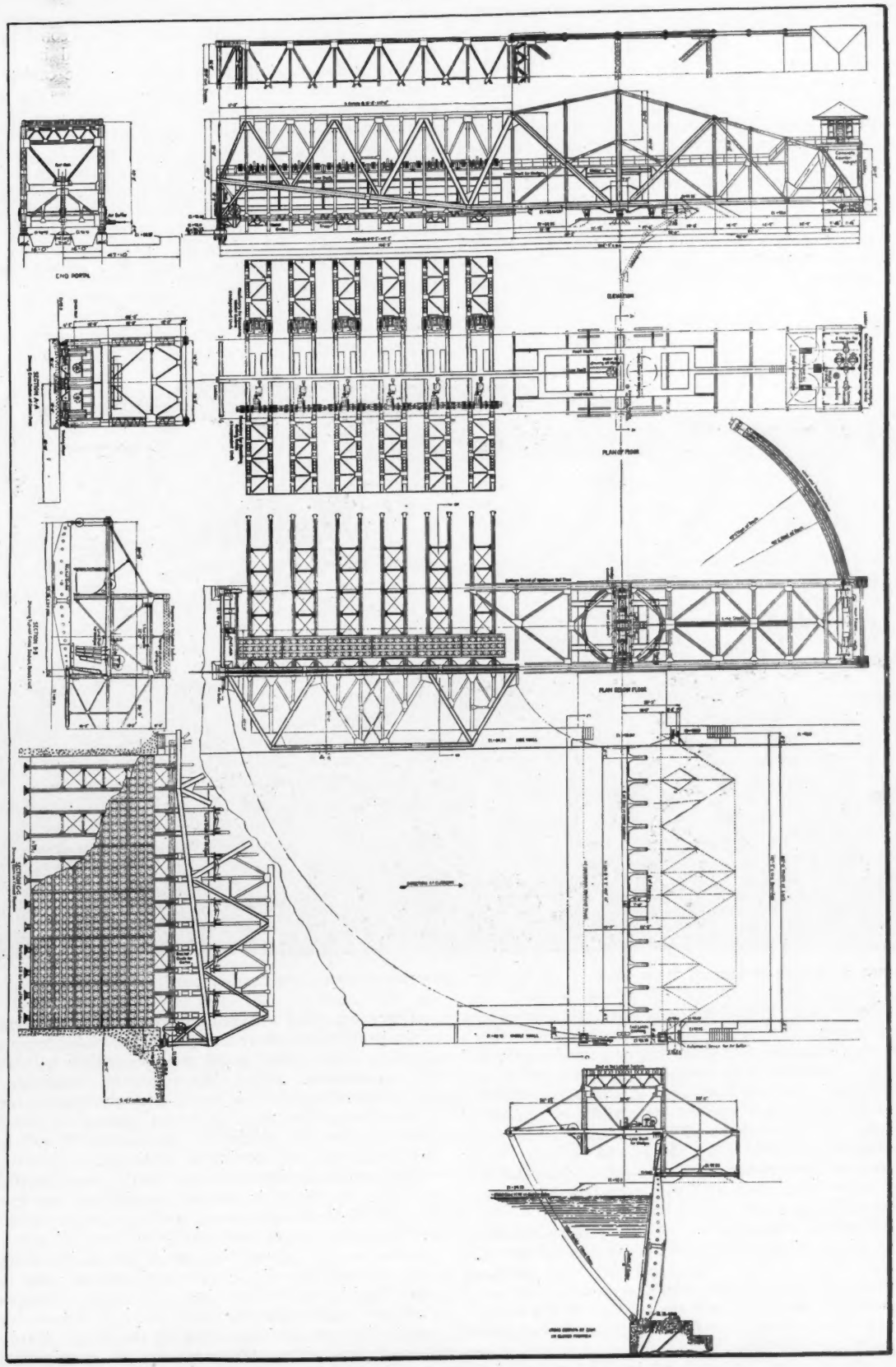


FIG. 1. GENERAL PLANS AND CROSS-SECTIONS OF PANAMA EMERGENCY DAMS

gates proper, and that their size must be approximately the same, it can be readily appreciated that the bridge or crane that places each of them in place must also be of extraordinary size and strength.

The bridge is placed on a side wall of each main set of locks, and at those portions adjacent to the lakes from which they are supplied with water. Each bridge turns and transversely crosses the lock for which it is intended, by means of a turntable arrangement, and when properly positioned has its main dam girders alined with a slot provided in the floor of the lock. The girders are hinged to the lower portion of the bridge or crane and are primarily held up out of the way by means of a cable and pulley arrangement. The girders are braced together in pairs by cross trusses and the cables are connected to a set of drums which in turn are operated by a large motor. The bridge or crane is provided with a short arm to balance that part, that crosses the lock, and this arm is arranged with an operating tower and a suitable weighted concrete housing. In order to provide a closure for the spaces between the girders, a number of large plates are provided and these are supported from the bottom of the bridge, by chains and pulleys. There are 5 sets of these plates, 4 being hung as described and the other set being connected to the girders so that they will actuate with them.

The general operation of the safety gates or emergency dams is as follows: The operator in the tower in the short arm of the bridge, sets the main turntable motor into action, and this brings the bridge across the lock, where it stops. The main girders of the dam or gate are then permitted to fall into the lock space until their end portions come into contact with the downstream side of the slot provided in the bottom of the lock. The slot is so positioned that a slight angular position is given to the girders when they come to rest against its side. The girders are dropped by setting the motor that controls their drums for the cables, into motion, and the pulleys over which the cables run serve to give the necessary control over them. After the girders are placed the plates are dropped vertically into position on the girders, which they readily do, owing to their normal horizontal position on the bridge and the angular rake of the girders, the motor controlling the drop of the plates being set into motion from the tower by the operator at a predetermined time. By an arrangement of guides and cables the plates are further controlled in their movement so that they cannot become misplaced on the girders.

FIG. 3. GATUN SPILLWAY, VIEW LOOKING SOUTHWEST, SHOWING DOWNSTREAM FACE OF OGEE DAM, JUNE 6, 1912

There are many details of interest in the construction of the bridge but as they are specially intended to improve the dam from a mechanical standpoint they will not be referred to here, except that it may be mentioned that a 5-ton travelling crane is provided on the upper structure of the bridge for assisting in the general work of the apparatus and the placing of the machinery and heavy parts that may need moving or repairing.

One noticeable characteristic of the emergency dams or safety gates is their general simplicity of construction in spite of their massiveness, and the gradual and conservative method of putting their essential parts into position, as well as utilizing as far as possible the pressure of the water of the canal to keep the parts closed when positioned to keep the water back. This avoids great and sudden stresses, and thereby reduces considerably the risk, and the sizes of the parts of this important piece of apparatus, which is so necessary to the protection of the canal.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

A Vacation and an Advance

DEAR FATHER:—

Well, I arrived all safe after my vacation at home, and let me say right here, that home never seemed to be so good to me as it did this time after an absence of several years, and I never left it with so much regret.

It seems good, however, with all that, to get back on the job again. Of course the Chief was glad to see me—so was Hazel, too—but somehow or other it seemed so good to have the "gang" come over and stick out their dirty hands to welcome me back.

I have been here now about 3 years and although I studied hard at "Tech." and tried to get the worth of your money, yet I can see a great many places now where I ought to have improved a lot on a good thing. I have tried to keep up in my studies and review them from time to time, but every little while, something comes up that floors me for the time till I have a chance to think the matter over.

Still I suppose that this is natural. It is not possible for one to remember all that he has learned, or read, or even seen. Still I try to cultivate the habit of stowing away in my brain the general gist of a matter, rather than the actual words or expressions.

But enough of this. Since I have been away things have gone on just the same with a little change here and another one there, till the ideas on the blueprints are finally carried out.

Since I have been gone, however, the assistant engineer has left. He had a chance to go higher and take an engine room of his own and become a Chief himself. This left a vacancy here and the Chief managed to keep things going till I got here, although he admitted to me that he ran the air compressor one morning for half an hour without turning on the jacket water, and the fellow that he got from the "gang" to help out never noticed it either.

So, father, I am here in the engine room, as assistant to the Chief, and I think that I will like it all right. A vacancy occured also in the boiler room and Fred has come back, on my recommendation, and he says that he has learned his lesson and that he didn't know a good thing when he saw it when he left the job before.

Seems funny, doesn't it? Here I started in wheeling in coal and wheeling out ashes for Fred, then took the job of firing myself, and then into the engine room, and here he is still firing. Fred says that he has taken up a university extension course and that he has got as far as fractions, and that he is going to learn the business now and learn it right, or he is going to know the reason why.

About the first thing that began to hoodoo me after I got into the engine room, was a small duplex pump used to fill a small tank out in the works whenever required. It takes water from the hot well and pumps against a head of about 30 lb.

Well after I had begun to get the general run of everything, and traced out all the piping, etc., this pump became endowed with some sort of an evil spirit, so I thought, and worked slowly till finally it stopped with both pistons at the water end.

Open the overflow valve at the pump, back of the check in the discharge line, and it ran all right, but as soon as this was closed and the discharge thrown into the tank, it began to get the rheumatism and finally would stop. Of course I looked everywhere but in the right place. Valves all in good shape, plungers packed properly, and then I looked at the steam valves and even these seemed to be all right.

Of course I took the cylinder heads off. The cylinders are cast in one piece and the heads for both are also in one piece. The gasket came off with the head and it did not occur to me to look at the head, so after satisfying myself that the steam pistons were all right, I put the head on again.

Nothing doing. This began to get on my nerves. Finally I took the head off again, out of spite, and found that the gasket had blown out between the 2 cylinders so that the steam passed from one to the other through the opening, and forced the pistons both to the water end, when the pump would stop.

I learned right then that trouble is sometimes found where it is not supposed to be. That same day I noticed that the crankpin on the low-pressure side suddenly began to pound hard and yet when you stood beside it, it didn't seem to be there either. When the Chief came in, I called his attention to it. He smiled and went around and adjusted the dashpot and lo! the pound was gone.

The engine has guards completely enclosing the cranks, and the Chief explained to me that these crank guards act as a sort of telephone receiver and magnifier, and collect all the little noises about the engine and blame them all on the crankpins.

Of course there are the usual Sunday jobs, that have to be done, and it is quite annoying sometimes to have the day spoiled by having to go down and pack the valve stems, or the pump, or clean the filter. The filter is called so by courtesy only, for it has a brass plate on the side that tells the unsuspecting public that it really is an oil filter.

I don't know whether I can do it or not, but I am going to try to design a filter, and a filtering, storage and oiling system combined and get the Chief's opinion on it. It seems to me that there is too much oil used here, and if I can save part, or nearly all of it, that is so much to the good.

I was over to the Chief's last evening (of course Hazel was the magnetizing force), and before I knew it, the Chief and I were discussing valve gear diagrams, sketching them on a small drawing board, he has at home, and working out the interesting problem of inertia governors.

This is something that the Chief has not had the chance to study and, as it was one of the most absorbing subjects that I took at "Tech," I felt that the subject was one that I could talk about with at least some degree of intelligence. We pored over lap circles, lead, radius of eccentricity, overtravel, angle of advance, and all that business till we were oblivious to everything else.

Well, father, I feel so much better since I came back from a visit to "the old homestead." It seems to have raised me to a higher plane, one where I can see things in a broader light. I believe that I was sort of getting into a rut, so to speak, for I had not lost a day since coming here to work, 3 years ago. After this, I am going to take a vacation of a week or so at least once a year.

Well it is after 9:30 and I must be climbing the wooden hill. Thank mother again for the mince pies. Hazel can make mince pies too.

Affectionately your son,

Donald C. MacDougal.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

DAILY RECORD OF POWER AND PUMPING PLANT

ACCOMPANYING is a daily report sheet from an isolated plant where I am working. We run on a daylight and moonlight schedule. There is no current used in the day unless a dark day and the street lights are not used on moonlight nights. We have 2 Chuse high-speed engines, one 100-kw. and one 60-kw., d.c. and run whichever engine will carry the load best.

The pump is a horizontal compound, outside packed, pumping from an artesian well and against an average of 87 lb. pressure.

The boiler is banked when we shut down but must keep head of steam to start up at any time in

DAILY RECORD OF POWER AND PUMPING PLANT

JAN. 17, 1913

GENERATING UNIT	NO. 1 Start 9 45 P.M. Stop 6:30 A.M. Size 60 K.W.					
" "	NO. 2 Start 6:30 A.M. Stop 8:10 A.M. Start 4:25 P.M. Stop 9:45 P.M. Size 100 K.W.					
" "	NO. 3					
PUMP	NO. 1 Start 4 05 P.M. Stop 5 05 P.M. Start 9 45 P.M. Stop 5 30 A.M.					
"	NO. 2					
BOILER	NO. 1					
"	NO. 2					
"	NO. 3 Start 4 00 P.M. Stop 8:10 A.M. Size 150 H.P.					
AV. TEMP. FEED WATER. 203.2						
OUTSIDE TEMP. 6 P.M. 12 Above						
AV. STEAM PRESSURE. 127						
SAFETY VALVE OPEN TEST. 4 00 P.M.						
BOILER BLOWN. 2:00 P.M.						
OUTPUT---ELEC. K.W.H. 936				WATER-GAL. 385840		
COAL CONSUMED--LB. PER K.W.H. 6.26				LB. PER M. GAL WATER 12		
LB. COAL BANK FIRES. 600				TOTAL COAL. 11000		
ASH LB. 1061						
WATER USED IN BOILERS-LB. 76440						
RECORDING WATT METERS K.W.H.	1 A.M. 16.50	3 A.M. 27.50	5 A.M. 34.10	7 A.M. 77.00		
	9 A.M.	11 A.M.	1 P.M.	3 P.M.		
	5 P.M. 64.98	7 P.M. 108.10	9 P.M. 92.00	11 P.M. 38.25		
PEAK LOAD------K.W. 121.90			TIME - 6 10 P.M.			
REMARKS. Coal used Ill. Soft 13430 B.T.U. Cost $3.18 Per Ton						
The boiler, water tube, very poorly set as to baffles and exposure.						
125 4" tubes, 11' long						

REPORT SHEET

case of fire or a call for current. Exhaust steam is not used except to heat feed water through open Cochrane feed-water heater. Meters, steam gages, revolution counter and feed-water temperatures are read every hour. All coal and ashes are weighed and feed water measured through Worthing hot water meter. I wish to know how it compares with similar plants. T. F.

JAM NUTS

IN the November 15 number, page 1150 of Practical Engineer, is an article concerning lock nuts, by W. L., and what he says relative to location of thick and thin nuts for jamming purposes is true; he, however (no doubt by oversight), failed to mention one important point, in order to make a jam that will hold, the nuts must be faced true with the internal threads by screwing them on a snug fitting nut mandrel and the faced portion of the nuts must have less surface than the internal thread surface, this will make a perfect jam. If the face of the nut has more surface than the internal thread the nuts are likely to get loose no matter how they are placed and frequently both nuts will turn simultaneously. W. S. L.

PATCHING A BOILER

I NOTICED in our issue of Nov. 15, the description of a patch put in a return tubular boiler at the girth seam. I think it a bad error to place a patch in a place of that kind as described. In the first place, the edge of the boilerplate should not be scarfed; second, the patch should not be placed wholly on the outside of shell, but half inside of first sheet, the other half outside of second sheet; and third, all rivet holes countersunk and rivets driven flat, then the seam drawn up to place and calked well, but not scarfed.

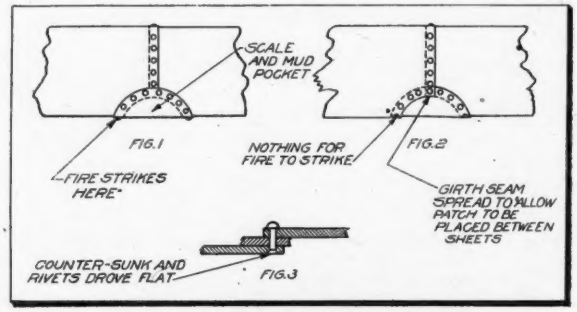


FIG. 1. PATCH WHICH FORMS POCKET
FIG. 2. PATCH WITHOUT POCKET
FIG. 3. CROSS-SECTION OF PATCH

Placing the patch on outside of shell altogether exposes the sheet to the fire and forms a large scale-pocket.

Boilers are set sloping from front to rear. Why? First, to make sure that back of flues are covered when water is low in column; second, so it will drain well when cleaning out, and third, so the sediment will work back to the blowoff, which it couldn't do if there is a pocket for scale to form in. W. S. H.

ELASTICITY IN CYLINDER HEADS

NO doubt a great many engineers of high caliber, who have given it no serious thought, have been led to believe through various arguments, that the cylinder head of a steam engine screwed on with a total pressure of 6000 lb. as illustrated in Fig. 1 is comparable to if not identical with, the weighted head illustrated in Fig. 2. There is a difference, and it was brought to the attention of the writer but recently by the editors of Practical Engineer after I had attempted to rectify an article by Geo.

H. Wallace relative to cylinder heads and studs, which appeared in the Dec. 15, 1912, issue of Practical Engineer.

The reason for the difference lies solely in the elasticity of materials, and I can find no simpler way of illustrating the variance than by Figs. 3 and 4. A is a solid piece of wood or metal clamped rigidly in a vise. B is an open coil spring under compression. C is a solid piece of wood or metal also under compression. D is a heavy rubber band under tension. The tension in the rubber band, of course, produces equal compressive forces in both B and C. It will be found that the slightest upward pull on C will increase the stretch in the rubber. The reason for this is obvious: we have highly elastic materials acting in both directions with equal force.

Now replace the spring with a second inelastic solid as indicated in Fig. 4. The initial stretch in the rubber will be the same but it cannot be increased until you pull with a force greater than the existing pull in the rubber. The reason is again obvious: the resisting materials, although in perfect equilibrium as in Fig. 3, are inelastic to any appreciable degree.

We can therefore rightfully compare Fig. 1 with Fig. 3, and we can also compare Fig. 2 with Fig. 4.

We know that all structural materials are elastic. The cylinder head and cylinder shell in Fig. 1 are therefore slightly compressed while the stud bolts are slightly elongated. Any steam pressure acting against the cylinder head causes an additional stretch in the stud and the stress in the stud increases simultaneously, just as the slightest pull on C (Fig. 3) causes added stretch and stress in the rubber. A total steam pressure greater than 6000 lb. will therefore be necessary to lift the cylinder head against the nuts, clear of the shell, and allow leakage of steam.

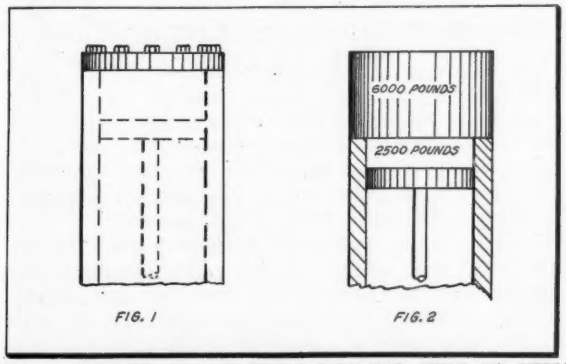


FIG. 1. METHOD OF ATTACHING CYLINDER HEAD TO SHELL
FIG. 2. COMPARING STRESS ON STUD TO DEAD WEIGHT

In Fig. 2 the elasticity of material although slightly active in the cylinder shell, can not affect results and steam will therefore escape as soon as the total pressure surpasses 6000 lb.

If, in Fig. 1, we could use elastic studs and inelastic cylinder shell and cover plate, as is usually assumed in practice, both cover-plates in Figs. 1 and 2 would leak steam the instant 6000 lb. pressure is passed.

In all problems of this character with which I have had experience, the large ratio of area under compression to area under tension permits us to assume inelasticity for the shell and plate, despite the higher modulus of elasticity of steel as compared with cast iron. Kent, in his Mechanical Engineer's Pocket Book, says, "Marks gives for number of bolts (for cylinder heads)

$$b = \frac{0.7854\ D^2 p}{5000\ c}$$ in which

c = area of single bolt in inches.
p = boiler pressure in lb. per sq. in.
D = diameter of cylinder, inches.
5000 = safe stress per sq. in. on the nominal area of the bolt."

The above, which is a typical designer's formula, does not caution one as to the elasticity of the materials involved. Perhaps the high factor of safety takes care of that. Still, even with the high factor of safety used, if one should screw up each stud just to the point of break-

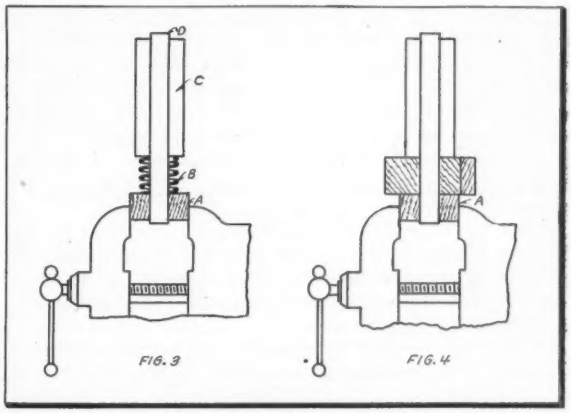


FIG. 3. COMPARISON OF CYLINDER MATERIALS TO HIGHLY ELASTIC BODIES
FIG. 4. ELASTIC STUD BOLTS AND INELASTIC HEAD AND SHELL

age and then turn steam into the cylinder, the studs would pull apart no matter what their initial strength, and no matter what the steam pressure. It therefore seems that studs can be screwed too tightly and perhaps that is why Kent says, "The diameter of bolt for the 10-in. cylinder is 0.54 in. by the formula, but ¾ in. is as small as should be taken on account of possible overstrain by the wrench in screwing up the nut."

The writer has many times broken studs of the above kind on steam and gas engines by tightening them while the engine was motionless, whereas he has never had the misfortune to have one break while the engine was in motion. Although I knew it to be a risky performance, I will confess that I have often tightened these studs while the engine was in motion. Why they did not break is a mystery to me now. I am therefore still of the opinion that in all ordinary cases one is safe in assuming cylinder head and shell as an incompressible material and further believe that where studs are of proper size and properly tightened, the tension in the studs is practically constant whether running or idle.

If, for example, we take a 6-in. cylinder and 12 studs, the following results are obtained, assuming a screwed tension of 500 lb. on each stud, and a steam pressure of 100 lb. per sq. in.; also inelastic material in head and cylinder:

Cylinder area = about 25 sq. in.
Total pressure at 100 lb. per sq. in. = 2500 lb.
Total pressure between cover plate and cylinder = 6000 — 2500 = 3500 lb.

Each bolt, save for the slight increase due to elasticity of the shell and cylinder head, would therefore be under the same stress when the engine is running as when the engine is idle, and it is only after the total steam pressure becomes greater than 6000 lb. that stress and the accompanying strain in the studs increase.

Of course, in problems of this kind where the area ratios are small, it is doubtless well to bear the elastic properties in mind.

W. F. Schaphorst.

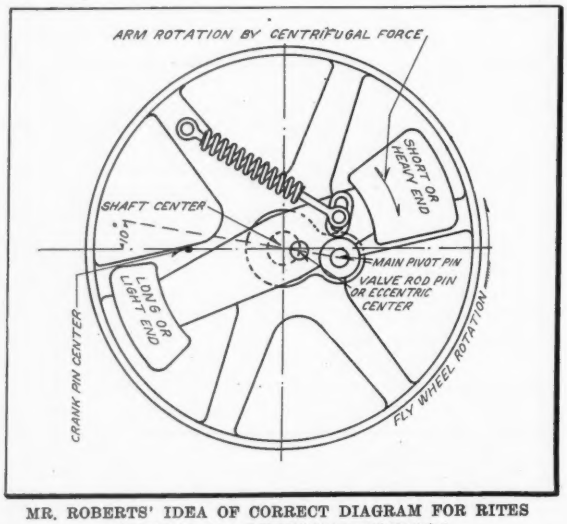
ADJUSTMENT OF RITES GOVERNOR

I WAS much interested in the article under the above heading by Sterling H. Bunnell in the Jan. 1 issue, but it seems to me he has made a mistake in saying and also showing in his drawing of the governor that the crankpin is about 10 deg. behind the center line on which the pivot pin is located.

It seems to me it should be just the reverse, that is, the crankpin should be about 10 deg. ahead of the center line on which the pivot pin is located. By examining the illustration which shows the above mentioned arrangement, you will see that the arc through which the valve rod pin, on eccentric center, swings when the governor arm swings from one extreme position to the other, is nearly at right angles to the center line of the crank, which condition is necessary for constant lead.

Of course it will vary somewhat, due to the arc through which the eccentric center, or valve rod pin swings.

Now take Mr. Bunnell's drawing and draw in the arc through which the valve rod pin will swing when the governor arm swings to the other extreme position and you will find that with that arrangement the lead will be extremely variable.



MR. ROBERTS' IDEA OF CORRECT DIAGRAM FOR RITES GOVERNOR IN OUTERMOST POSITION

Suppose that when the governor is in the extreme outer position, as shown in his drawing, the lead is reduced to zero, when it is in the other extreme position, as in starting up the engine, the lead will be excessive, enough so, it seems to me, to make the engine somewhat hard to start.

A few years ago I ran a small engine that had a shaft governor, but not a Rites, that worked just about like I think Mr. Bunnell's governor would work, except that instead of the lead varying from zero to an excessive amount, as in the above supposition, it was correct for the inner position of the governor, but a very small movement of the governor arm would reduce the lead to zero and by the time the governor was blocked out about half way the valve was lapped enough so that the crank had to turn through an angle of some 25 or 30 deg. before the valve would begin to open.

It seems to me that this is entirely wrong, that the governor arm should be so pivoted as to give the valve as nearly constant lead for all ranges as possible, except that it is desirable to have the lead reduced to zero when governor is in extreme outer position. What do others think about it? H. G. Roberts.

The last paragraph gives the key to the whole problem. It is absolutely essential that the lead with the governor in the outer or full speed position, shall be zero. If there were lead at this position of the governor, the engine would run away under no load. The governor must, when in its full speed position, practically blank the port.

Now, in the running position, which is generally at a point that will give ¼ to ⅜ cutoff, the valve must have enough lead to give proper running, and a good steam line. In order to get sufficient lead at the running position of the valve, the whole governor wheel must be rotated forward with respect to the crankpin; that is, the governor pivot pin must be placed several degrees in advance of the crank arm center line. By this means, the valve rod pin is give enough advance, so that it pulls the valve open a little as the crank reaches its center.

Unfortunately for theoretical perfection, the lead with the governor so set continues to increase as the cutoff is lengthened until in the extreme inward position of the governor arm the lead is somewhat excessive. However, this condition exists with every high-speed engine operating with Rites' governor. It is not seriously objectionable, because the extra lead insures the greatest possible steam pressure and the highest possible steam line during the part of the stroke up to cutoff, and so tends to increase the load-carrying capacity of the engine.

The standard single-arm Rites' governor, when properly set, gives practically zero opening at the commencement of the stroke, and a steadily increasing lead as the cutoff lengthens; the lead being made such as to give the best results when the governor is in its running position corresponding to a cutoff of ¼ to ⅜ stroke.

Sterling H. Bunnell.

KEROSENE OIL FOR REMOVING SCALE FROM BOILERS

I HAVE read with considerable interest the different methods submitted by engineers for removing scale from boilers. Whenever I read of a case where coal oil has been used similar to the case submitted by H. R. S., in the Nov. 15 issue of Practical Engineer, it recalls to my mind how I used kerosene oil with very good results in a boiler that was badly scaled.

When I took charge of the plant I was greatly surprised to find the boiler in the condition it was, considering that it was regularly inspected; the scale on the tubes, heads and some parts of the sheets was ⅜ in. in thickness.

I looked around to see if I could find the cause, as we were using city water, and the other plants in the neighborhood were having very little trouble from this cause. I found that the service pipe which supplied the boiler with city water had been connected to a "dead end" which means that we were the last on the street using water from the main; in fact, the street ended at the plant and the water main, of course, could go no farther. All sediment that collected at this point was pumped directly into the boiler, as the plant had no feed-water heater.

The plant was located on a corner and I had a connection brought in from the other street in order to avoid the "dead end."

About the time I took charge of the plant a new engine and boiler were installed, the extra boiler giving me a chance to see what I could do with the dirty one. Wishing to have the boiler in operation again as soon as possible, I used the following method: Taking 2 water pails filled with kerosene oil, I satu-

rated the tubes, heads, and all parts of the inside of the boiler that I could reach from the manhole, using a small tin cup for this purpose. The boiler was allowed to stand in this condition, with manhole and handhole plates in place for 24 hr. in order to allow the oil to penetrate the scale.

The boiler was then filled with water and operated at 5 lb. pressure for another 24 hr., the boiler being vented to the atmosphere in order to allow the kerosene vapor to escape. After allowing the boiler to cool sufficiently it was with much satisfaction that I noted the amount of scale that had come away from the tubes and sheets; this was more noticeable on the upper rows of the tubes and the sheet directly over the fire.

After removing all the scale I could reach I repeated the process as explained above. This operation was continued for about 3 weeks. At the end of that time I had practically a clean boiler; the worst trouble was removing the scale from between the tubes close to the heads. I operated this plant a little over 3 yr. and had no further trouble from scale owing to the change I made in the city water connections.

I have found that dissolved carbonate of soda introduced periodically gives good results, and I used it in the boiler which I have described after I had removed the scale by the use of kerosene oil. My opinion is that when dealing with dirty boilers some judgment should be used in regard to what is used to remove the scale. W. S.

MOTOR CONNECTIONS

THE accompanying sketch illustrates how I connected to a 50-hp. 500-volt series wound motor as a shunt machine on a 220-volt circuit.

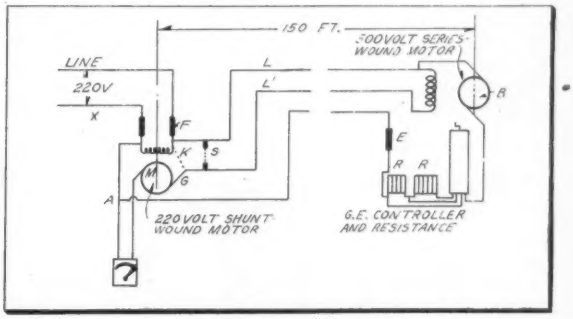
As is was desired to operate a power driven capstan by electricity instead of a long line shaft and the only available motor was an old 500-volt series-wound machine I had to do some real thinking.

The closest motor being about 150 ft. away and running the machine shop line shafting gave the suggestion, why not excite the fields of the series-wound motor with the current used to run the machine shop, by connecting the fields in series with the armature of the machine shop motor in the following manner: run 2 lines L L′ to the series motor B, and connect them to the fields, the other ends, I connected to F and G and then opened the line at K.

Now as the fields were excited the current required by the motor B at full load being 80 amp. while that to run the machine shop motor was about 40 amp. it became necessary to run current through the armature so a connection was made at A and run parallel with L L′ to the controller through a switch and fuse E, then through controller to the armature; the other side of armature was connected to L. If the connection had been to L′ the wiring would have had a compounding effect which was not desirable on account of the variation in speed and furthermore, if the motor M were not operating, B would then operate as a series motor which would be rather a risky thing since the capstan was used to pull cars in and out of the building and was of the endless rope kind, the load varying from no load to full load while the motor was running.

As the motor B was not used more than an hour a day a switch was placed at S for the purpose of cutting out the fields of B and thereby doing away with the drop in L L′ and the fields, this switch merely short circuited the fields.

The fuse at E protected the motor B in case some person desired to run it when M was not running or when switch S was closed.



INGENIOUS MOTOR WIRING

As motor M was always running this wiring proved very satisfactory, besides bringing about a considerable saving in power as the capstan was formerly run by line shafting 150 ft. long from the machine shop motor, it also gave 3 speeds which can be increased to 5 at any time desired by merely running 2 more lines from the controller to the resistance R. C. R. Weihe.

AIR HUMIDIFIERS

WHEN installing heating and ventilating systems in large city buildings, it is advisable to make some provision for an air washer and humidifier for the purpose of removing impurities from the air drawn from outer atmosphere, also a humidistat in connection for regulating the moisture which the air carries with it.

When air washers and humidifiers are used in connection with the heating system for the purification of the air from the outer atmosphere, fresh water supply for feeding the boilers which is required to replace that lost by the various wastes, may automatically be taken from pan at the bottom of humidifier, which is continuously flowing by gravity into heating system ejector and being drawn into suction of vacuum pump. This pump is also used in connection with heating system for the purpose of relieving it of its air and condensation into a vented receiver.

The water used for purification of the air in blower system, is discharged from pan by means of a centrifugal pump (which receives its motive power from the shaft, also used for driving the blower) to top of humidifier, into horizontal perforated pipe, flowing by gravity over zigzag wire screening into pan below. Fresh water is admitted to this pan by means of an automatic tank valve, as a certain amount of this water is used along with the returns from heating system. L. A. Danner.

FILLING A BOILER

I HAVE found it advisable when filling boilers to close all outlets, draw up manheads securely and let entering water create an air pressure in boiler, then to go over the manheads with candle. If a leak exists the escaping air will blow the flame. This will save a possible dumping of boiler or at least a cooling off. On return tubular boilers I have never had a leaking manhead when above test was made. J. C. Lee.

FINDING PROPER SIZE BUSHING FOR REDUCING GEAR

IN a back number of Practical Engineer, W. E. A. in questions on steam engine asked how to find the proper bushing for the reducing wheel and F. L. Johnson answered that such bushings are usually marked by the makers with figures denoting the stress of piston for which each is suitable. I will say that it is not always the case, at least the one I have is not so marked.

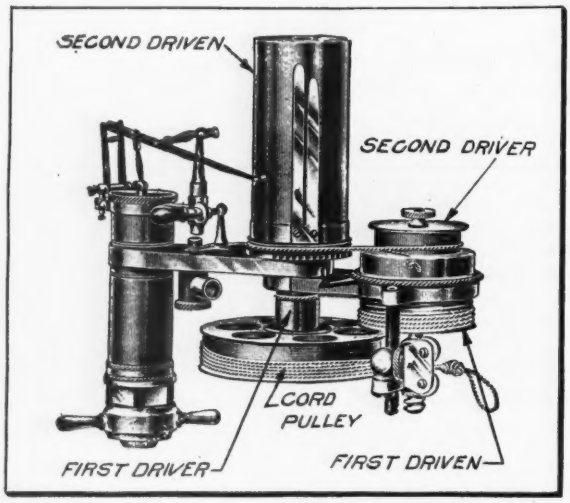


FIG. 1. INDICATOR REDUCING MOTION

When the bushings are not marked, the following method will answer the question. This formula is based on the rules of calculating the speed of pulleys.

I designated the reducing gear as you will notice in the illustration, namely, cord pulley, first driver, first driven, second driver and second driven. We will assume that the stroke of the piston is 24 in., cord pulley 3 5/32 or 3.15 in. (for sake of ease in figuring we will use decimals instead of fractions), first driver 13/16 or 0.8125 in., first driven 2 in., second driver unknown and the second driven 1¾ or 1.75 in., and the length of the diagram we wish to have 3¾ or 3.75 in.

First of all find the circumference of cord pulley and divide the stroke of the piston by this length. This will give you number of revolutions of the pulley which in this case will be $3.15 \times 3.1416 = 9.9$, $24 \div 9.9 = 2.4$ revolutions, and as you will notice that the first driver is located on the same shaft with the cord pulley, therefore, this will also give you number of revolutions of the first driver, which is 2.4.

Now find the number of revolutions of the first driven, multiply the diameter of the first driver by its number of revolutions and divide by the diameter of the first driven, which is 0.8125. $0.8125 \times 2.4 = 1.95$, $1.95 \div 2 = 0.975$, the number of revolutions. You will also notice that the second driver is located on the same shaft with the first driven, therefore, the number of revolutions of the second driver is the same as of first driven, which is 0.975. Now find number of revolutions of the second driven; find the circumference and divide it by the desired length of diagram, which is 3.75 in., now, $1.75 \times 3.1416 = 5.5$, $3.75 \div 5.5 = 0.68$, revolutions of second driven. Now to find the size of the second driver (or needed bushing), multiply the diameter of the second driven, by its number of revolutions and divide by the number of revolutions of the second driver, which will be $1.75 \times 0.68 = 1.19$, $1.19 \div 0.975 = 1.2+$ or about 1 7/32 in., this is the size of the required bushing.

For convenience, rule may be stated as a formula as follows:

L = stroke = 24 in.
D = diameter of cord pulley = 3.15 in.
D_1 = diameter of first driver = 0.8125 in.
D_2 = diameter of first driven = 2 in.
D_3 = diameter of second driver = $\times$.
D_4 = diameter of second driven = 1.75 in.
L_1 = length of diagram = 3.75 in.
N = number of revolutions.

$$N \text{ of } D = \frac{L}{D \times 3.1416} = 2.4$$

$$N \text{ of } D_2 = \frac{D_1 \times N^{*} D_1}{D_2} = 0.975$$

$$N \text{ of } D_4 = \frac{L_1}{D_4 \times 3.1416} = 0.68$$

$$D_3 = \frac{D_4 \times N\ D_4}{N\ D_2} = 1.2+$$

*$N\ D_1 = ND$ (on same shaft).
$ND_3 = ND_2$ (on same shaft).

When taking card of high speed engine we usually take shorter card about 2½ in. in order to get a reliable diagram.

In this case you do not have to go all over your data, just divide the length of desired diagram by the circumference of the second driven, next, to find second driver multiply the diameter of second driven by its number of revolutions and divide by the number of revolutions of the second driver, which will be: $1.75 \times 3.1416 = 5.5$, = circumference of second driven, $2.5 \div 5.5 = 0.45+$ = revolutions of second driven, $1.75 \times 0.45 = 0.7875$, $0.7875 \div 0.975 = 0.8+$ in. = diameter of second driver.

LENGTH OF CARD	STROKE OF ENGINE												
	10	12	14	16	18	20	24	30	36	42	48	54	60
2	1.55	1.29	1.11	.97	.86	.78	.65	.52					
2¼	1.75	1.45	1.25	1.09	.97	.88	.73	.58					
2½	1.94	1.61	1.38	1.21	1.08	.97	.81	.65	.54				
2¾	2.13	1.77	1.52	1.33	1.18	1.07	.89	.71	.59	.51			
3				1.45	1.29	1.16	.97	.76	.65	.55			
3¼				1.58	1.4	1.26	1.05	.84	.70	.60	.53		
3½						1.36	1.13	.91	.75	.65	.57	.50	
3¾						1.45	1.21	97	.81	.69	.61	.54	.48
4								1.03	.86	.74	.65	.57	.52
4½											.73	.65	.58
5											.81	.72	.65

FIG. 2. SIZE BUSHING FOR REDUCING MOTION

If the indicator is used a great deal on engines of different size and speed it would pay to work out a small table, as shown here, giving diameters of bushings for different strokes and lengths of cards and paste the table in the indicator box. M. Strosk.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Kink With Chain Block

YOU will find this a good kink when using a chain block, for you can hoist a load to any place or height without having to block up underneath to change sling.

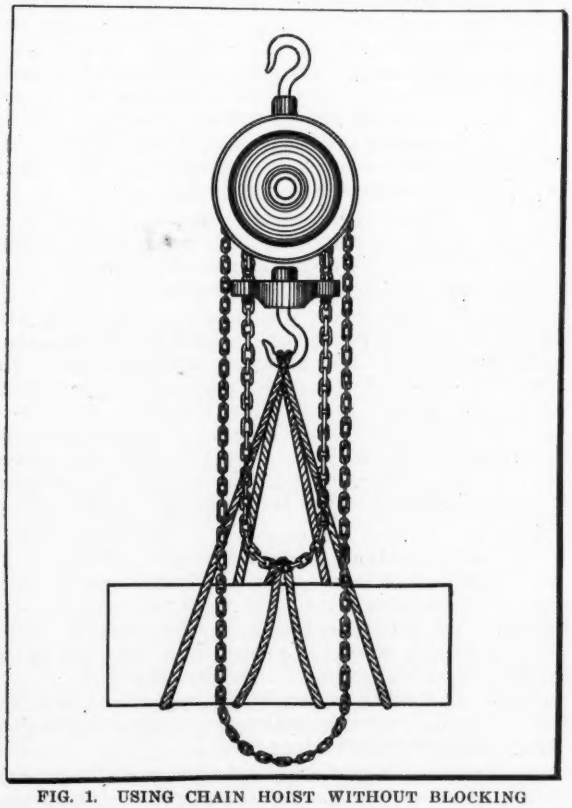


FIG. 1. USING CHAIN HOIST WITHOUT BLOCKING

When you have pulled the load as high as the hook will allow, put a sling around the load and make fast to the loop of the large chain, then backing off

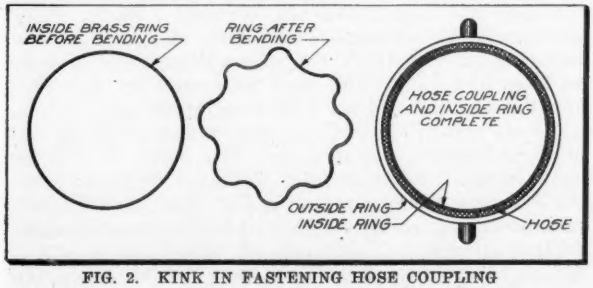


FIG. 2. KINK IN FASTENING HOSE COUPLING

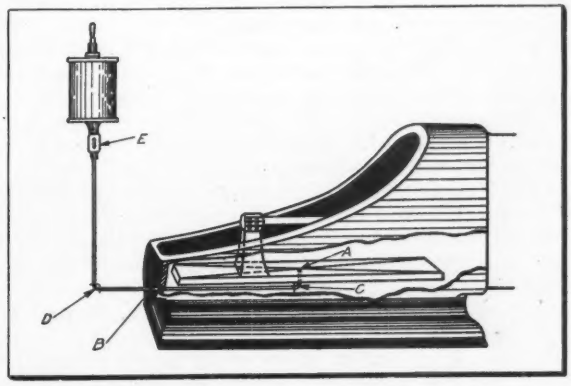
on the load by pulling the hand chain the other way, will continue to raise load. This is convenient to raise the load just one more inch.

Some people find it a difficult job to connect up a high-pressure hose if it pulls out of coupling. I have fixed them with good results by bending the inside ring, as shown, and after placing hose in coupling slipping ring in place and with a piece of pipe and hammers bend it out into place. If hose is large enough you can use a flue expander with good results.

O. McGrady.

Oil Rigging for Tail Slide

A VERY satisfactory oiling arrangement can easily be installed on almost any gas engine tail slide by drilling a hole for a ⅛-in. pipe in the center of the slide and countersinking as shown in the sketch at A, then cut a piece of pipe several inches long, thread one end and screw an ell on it, stick the pipe up through the hole A till it comes flush with the top of the slide, take a tapered punch and drive in the pipe; this will spread the pipe open. Then take a calking tool and seal the end of the pipe, this will prevent the oil from leaking and keep the pipe from dropping down. After this has been completed, cut a piece of pipe the desired length and thread each



DEVICE FOR OILING TAIL SLIDE OF GAS ENGINE

end, run through hole B and screw in to ell C; next, cut a piece of pipe about 6 in. long and screw into the ell D, with a ⅜ to ⅛-in. reducer, a sight feed oiler can be screwed on at E.

The oil can then be properly regulated so as to keep the slide perfectly lubricated. The cup being several inches higher than the slide, the pipe will stay filled with oil and the shoe will spread the oil out in the grooves. The oil can be drawn off when the slide fills up and be used over again. Before I installed this system of lubricating the slides it required nearly 1 gallon of oil a day to keep 1 slide lubricated; with this arrangement it takes only a little over a pint a day to the slide. J. B. Linker.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Examination for Mine Hoisting Engineers, Springfield, Ill.

USING 12,000 lb. of coal in 8 hr. to do hoisting and pumping and to run the fan, the feed-water comes in at 45 deg. F. How much coal would be used if the same work is done and water is put into the boiler at 95 deg. F.?

2. How would you prepare a boiler for cleaning?

3. What is an indicated horsepower?

4. What are the laws in reference to signals?

5. A tank of water is 8 ft. in diameter at the top and 12 ft. at the bottom, and is 12 ft. deep. If we are using 34.4 hp. how long would it take to empty the tank?

6. A boiler is allowed 150 lb. pressure per square inch with steel of a thickness of 0.045 in. If the tensile strength of the steel is 60,000 lb. to the square inch, what thickness should be allowed in a pipe 22 in. in diameter to carry this same pressure?

7. What is the method of fastening a rope around a drum?

8. What is the breaking strain of a 1⅛-in. steel wire rope and what is its working load?

9. If there is a pounding in the cylinder of the engine in the morning after you had started the engine, what would you think was wrong?

10. A lodge in a mine is 26 ft. long, 8½ ft. wide, 7½ ft. deep and is full of water. How long would it take a 4-in. pump running at a piston velocity of 1200 ft. a minute to empty the lodge? Two 2-in. pipes are running full into the tank at a velocity of 1200 ft. a minute and the slip of the pumps is 10 per cent.

11. A boiler 54 in. in diameter has a grate surface of 18 sq. ft. What size safety valve would you use on it if of lever form and what size is spring loaded?

A. If the feed water were supplied at 95 deg. instead of 45, the saving would be 50 deg. One per cent saving is reckoned for each 10 deg. rise in feed-water temperature, which would give 5 per cent saving in this case. 5 per cent of 12,000 would be 600 lb. and the amount of coal used would be 11,400. Another way of figuring this would be to assume that a pound of coal will evaporate 10 lb. of water. 12,000 lb. of coal would then evaporate 120,000 lb. of water, and saving 50 deg. in temperature would save about 50 B.t.u. per pound of water evaporated. We should have then $50 \times 120{,}000$ which would be 6,000,000 B.t.u. saved in 8 hr. If the coal averages 13,500 B.t.u. per pound this would make a saving of $6{,}000{,}000 \div 13{,}500$ or 444 lb. of coal. This subtracted from 12,000 would leave 11,554 lb. used during the 8 hr.

2. In preparing a boiler for cleaning, the first thing is to let out the fire and cool the boiler. If possible all night should be taken in cooling down the boiler so as to avoid sudden temperature changes with the resultant strains. The boiler should be pumped up to 3 gages and left standing for 3 or 4 hr. to cool down, then it should be blown down, pumped up again and left to stand for a time longer. This operation repeated several times will cool the boiler down gradually and have it in shape to clean by the following day. Blow down all the water in the boiler, take off the front manhole plate for a horizontal boiler or the top manhole plate for a vertical boiler, and wash down the boiler with warm water. The cleaning process can then be completed by using a scale remover or tube cleaner, taking out all the scale so removed and again thoroughly washing down. When starting up the boiler after cleaning and inspection, new gaskets should be put on where needed, the boiler filled with fresh water and steam gotten up gradually.

3. An indicated horsepower is the power shown from the indicator diagram. It is a power developed by the steam inside the cylinder and represents the total energy delivered by the steam to the piston. In figuring the horsepower the necessary quantities are the mean effective pressure derived from the indicator card, the length of the stroke in feet, the area of the piston in square inches and the number of working strokes per minute, which, if the engine is single acting, will be the same as the number of revolutions, and if double acting will be twice the number of revolutions. If the horsepower of each end of the cylinder is figured separately it is the same as a single acting engine.

4. Laws in regard to signals are as follows:

At every mine operated by shaft and steam power, the means of signaling to and from the bottom man, the top man and the engineer, shall consist of a tube or wire incased in wood or iron pipes, through which signals shall be communicated by electricity, compressed air or other pneumatic devices or ringing of a bell. The following signals are provided for use at mines where signals are required.

From the bottom to the top: One ring or whistle shall signify to hoist coal or the empty cage, and also to stop either when in motion. Two rings or whistles shall signify to lower cage. Three rings or whistles shall signify that the men are coming up; when return signal is received from the engineer, men will get on the cage and cager shall ring or whistle one to start. Four rings or whistles shall signify to hoist slowly, implying danger. Five rings or whistles shall signify accident in the mine and a call for stretcher. Six rings or whistles shall call for a reversal of the fan.

From top to bottom, one ring or whistle shall signify: All ready, get on cage. Two rings or whistles shall signify: Send away empty cage. Provided that the operator of any mine may, with the consent of the inspector, add to this code of signals in his discretion, for the purpose of increasing its efficiency or of promoting the safety of the men in said mine, but whatever code may be established and in use at any mine, must be conspicuously posted at the top and at the bottom and in the engine room, for the information and instruction of all persons concerned.

5. The rule for the contents of a cylindrical tank, different diameters top and bottom, is as follows: Square the top diameter, square the bottom diameter, multiply the top diameter by the bottom diameter. Add these 3 products together and multiply by the height of the tank and by the constant 0.2618. The result will be the contents in cubic feet. For the tank given this gives: $8^2 = 64$. $12^2 = 144$. $8 \times 12 = 96$. The sum of these three is 304. Multiplying by the height, 12, and by the constant, gives 955 cu. ft., which at 62.5 lb. per cubic foot would give 59,650 lb. A standard boiler horsepower uses 30 lb. of water an hour, 34.4 horsepower would then use 103.2 lb. of water an hour, and the supply in the tank would last as many hours as 59650 is divided by 103.2, or 578.5 hr.

6. A boiler carrying 150 lb. pressure, of steel having a thickness of 0.045 of an inch and made of steel of 60,000 lb. tensile strength, would have a factor of safety equal to $60{,}000 \times 0.045 \div 150$ times the radius of the boiler, and this radius is not given. In any case the thickness, 0.045, is altogether too small. For a 22-in. pipe the proper thickness would be found by multiplying the pressure by the radius and by the factor of safety, which we will assume is 6, and dividing by the tensile strength of the metal.

$$\frac{150 \times 11 \times 6}{60{,}000}$$

gives 0.165 or about 11/64 of an inch.

7. A cable is fastened to the drum by taking 2½ laps around the drum which will not unwind at any time, then clamping to the drum by means of a clevis with nuts on the inside of the drum.

8. The breaking strain of a 1⅛-in. wire rope of plow steel, according to the latest tables of the manufacturers, is 47 tons and the working load 9½ tons.

9. Pounding in the cylinder of an engine may be due to different causes. If it is a sharp metallic knock it is probably due to water in the cylinder. If it is a heavy pound it is probably due to the piston being loose on the rod or to lost motion in the crosshead which appears to give a pound in the cylinder.

10. This question can only be answered by a series of approximations. We would have to find, first, how long it would take the pump to empty the lodge if no water were flowing into it, then find how much water would flow in from the pipes in that time and how long it would take the pump to take out this additional amount of water, then the amount of water that would flow in this additional time, and so on indefinitely. We can shortly see how far it would pay to carry this approximation. For the dimensions $26 \times 8\frac{1}{2} \times 7\frac{1}{2}$ for the lodge, we have the product of these 3 amounts, or 1653 cubic feet. As no right-minded reciprocating pump would consent to operate at a piston speed of 1200 ft. a minute, evidently the question means a centrifugal pump with a 4-in. inlet, carrying the water at 1200 ft. a minute. The area of a 4-in. pipe would be 12.57 sq. in. or 0.873 sq. ft. At 1200 ft. a minute the volume flowing would be 0.873×1200, or 1049 cu. ft. per minute. The time for the pump to draw out the water would then be $1653 \div 1049$ or about 1.58 minutes. The in-flow during this time would be the area of 2 2-in. pipes multiplied by 1200 and by 1.58. The area of a 2-in. pipe is 3.14 sq. in., and for 2 pipes would be 6.28 sq. in. or 0.0436 sq. ft. Multiplying this by 1200 would give us 52.3 cu. ft. flowing in, and the time needed by the pump to take out this amount of water would be $52.3 \div 1049$ or about 0.05 of a minute. It is evidently not worth while to carry the approximation further, as the time occupied to pump out the water already in and what would flow in would be $1.58 + 0.05$ or 1.63 minutes.

11. For the boiler having a grate 18 sq. ft., which is a reasonable assumption for a 54-in. boiler, we should have according to the Massachusetts Board of Boiler Rules, which is the best standard authority, and assuming the boiler to carry a pressure between 50 and 100 lb., a diameter of 3½ inches for a lever valve and for a direct spring loaded valve under the same conditions would have an area of 3 inches. The rule for the spring loaded safety valve is that the area in square inches must equal the weight of water in pounds evaporated per square foot of grate surface per second, multiplied by 770 and divided by the absolute pressure at which the safety valve is to blow.

Steam and Coal Consumption

IN a power system there is a 6 per cent line loss, a 20 per cent loss in the generator and 5 per cent friction loss. We operate 125 lamps and one electrically driven fan taking 14 amp. I should like to know the steam consumption of the engine, which is a 10 by 10-in. Ames running at 350 r.p.m., and how much coal it should require for the work.

I should also like to know the steam and coal consumption necessary to operate a compound pump, 14 by 20 by 18 in., working against 140 lbs. pressure; steam pressure, 100 lb. Subscriber.

A. With a line loss of 6 per cent, the energy transmitted by the line will be but 94 per cent of that generated. If the generator loss is 20 per cent, then only 80 per cent of the work put into it will be given out, and with a 5 per cent friction loss, only 95 per cent of the engine power will be transmitted to the generator. Hence, the efficiency of the plant as a whole is $0.94 \times 0.80 \times 0.95 = 0.7144$, or 71.44 per cent.

The 125 lamps will use approximately 12 hp. and the fan a little over 4, or a total of say 16 hp.

To realize 16 hp. with an efficiency of 71.44 per cent would require that the engine develop 22.4 hp. or less than one half an economical load for a 10×10-in. engine. Under such conditions the engine would probably require about 40 lb. of steam per horsepower hour or $40 \times 22.4 = 896$ lb. of steam per hour. If 8 lb. of water are evaporated for each pound of coal burned, the coal required by the engine will be

$$\frac{896}{8} = 112 \text{ lb. per hour.}$$

A compound direct-acting steam pump in good operating order will develop a horsepower on 50 lb. of steam an hour.

As the weight of water delivered is not stated, it is assumed that it will be 1000 gal. or 8300 lb a minute. One-hundred-forty pounds pressure is equivalent to a head of 322 ft. and to raise 8300 lb. 322 ft. a minute will require

$$\frac{8300 \times 322}{33{,}000} = 80 \text{ hp.}$$

to which should be added 25 per cent for friction. At 50 lb. of steam per horsepower hour, and an evaporation of 8 lb. of water per pound of coal, the amount required per hour will be

$$\frac{100 \times 50}{8} = 625 \text{ lb.}$$

F. L. Johnson.

Problems For Discussion By Readers

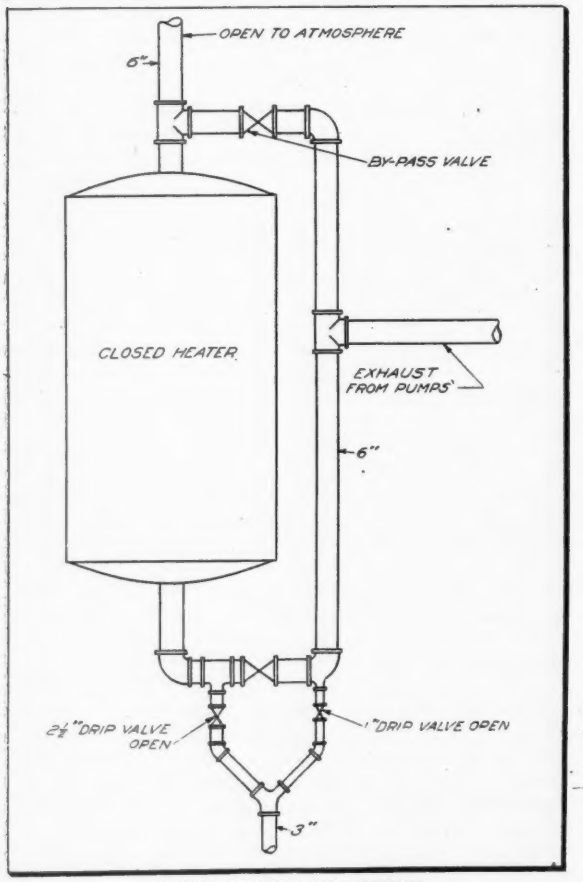
What Would You Do If You Had These Conditions To Meet?

Pump Springs

WILL some reader kindly furnish me with a rule for determining the size of spring wire for different lifts of suction pumps? A. M. J.

Heater Problem

A CLOSED National heater, piped as shown in the figure, and taking steam from the exhaust of 4 pumps will not drain itself of the condensed steam



CLOSED HEATER AND PIPING

while in full operation. Can some reader suggest a remedy? A. J.

Storage Battery Problem

IN reply to question by J. R. L., in regard to storage batteries, the writer has been in charge of a small electric lighting plant of 2 units with which is connected a 320-amp. storage battery, for about 4 yr., and can truthfully say that it has been a saving investment from the start and has not cost one cent for repairs up to date. It is used chiefly to furnish night current and also part of the day when the load is light.

In my opinion a storage battery is just the thing in places where outside current is not available and the load is such that it does not warrant the continuous running of a generator, thus effecting a saving in coal and labor. H. O.

Stuffing Box Problem

IN answer to the stuffing box inquiry in the issue of January 15; it is my opinion that the nuts on the gland will, with some engines, frequently work off; if, for instance, the packing is worn badly, you can notice a considerable backward and forward motion of the gland during one revolution, especially on long stroke engines such as the Corliss type. J. C. Lee.

Gage Glass and Stuffing Box Problem

AMONG the problems for discussion in the issue of Jan. 15, I notice one from E. C. B. on "What caused the glass to break." As I do not know what caused the breakage I will not attempt to answer it, but will say, however, that the fireman knew what he was talking about when he said it was a "foolish idea" to think the rubbing of the glass with a knife blade would cause it to break.

The same thing has been told the writer but was never believed. I have put in many glasses that had the label removed just as the fireman did and they always held as well as any that was never touched with a piece of metal.

As long as there is no scratch produced on the glass it is in nowise affected and it may be added that the average pocket knife found around steam plants is not likely to attack a gage glass any too viciously.

With reference to Mr. Hastings' question concerning the stuffing box problem, I am inclined to think the day engineer's explanation is correct.

When he says the stuffing box blew out I suppose the gland was meant, instead of the box. If the box was packed so full that only ⅛ in. of the bolts extended beyond the gland, the job was done wrong, and it is strange the nuts did not come off sooner than they did.

The idea is erroneous that the packing would swell and grip the rod sufficiently to force the nuts off, providing they are on the studs as much as the thickness of themselves, assuming that soft packing was used.

But in this case it seems the nuts had a purchase of possibly 1 or 2 threads, which probably was insufficient to retain the gland and packing against the thrust of the steam pressure.

Nuts will sometimes work off the studs and to prevent this should be secured by a lock-nut.

When the packing is compressed tightly by drawing up the nuts the strain on them is more uniform and

they are not so likely to work loose, but as the packing wears and becomes less tight the nuts are then subjected to a blow from the gland each time steam is admitted to that end of the cylinder, and eventually may work entirely off the studs.

The writer once had an experience similar to the one in question. On a Sunday the engineer on the opposite shift packed the piston rod of an engine driving a paper machine. He put in so much packing that the lock nuts had only 1 or 2 threads to hold with.

On the following Tuesday at about 9 p. m., without any warning the gland blew off, the packing of course following. As the crosshead carried the gland back the bolt holes failed to pass over the studs, the gland doubled up the studs, and was broken in several pieces.

The neck of the gland was driven into the stuffing box and stuck there. It all transpired in a half revolution of the engine, and seeing no further damage could occur, with the possible exception of the rod being scored by the neck of the gland coming in contact with it, the engine was not even slowed down, but ran the remainder of the week in this condition.

The nuts showed no sign of being stripped off the studs, and neither did the threads on the studs show any damage, save where the gland had jammed them as it was forced back by the crosshead. The nuts had all dropped off and were found lying on the floor.

Jos. Stewart.

Rollins Engine Problem; Massachusetts Examinations

ON page 1257 of the Dec. 15 issue of Practical Engineer, H. C. says he is having trouble with a Rollins engine but fails to state what that trouble is and without knowing definitely what he encounters it is impossible to give him just the information needed.

However, I should say he was desirous of adjusting the valve motion, and the method of setting the valves may be briefly stated as follows:

Adjust the eccentric rod so that when the eccentric is turned from one dead center to the other, the rocker arm will move equally each side of its supporting stud. Adjust the hook rod so that when the eccentric is turned from full throw to full throw the wristplate will travel equally each side of its support. Put the governor on the starting or safety-pin and adjust the dashpot rod to cause the hook on the guide stirrup to clear the lifting block on the bell crank 1 by 1/32 in. as shown in Fig. 2 after having first so adjusted the steam rod 6, from the wristplate to bell cranks 1 and 2, so that the stud holding the lifting block will be raised and lowered an equal distance on each side of the stud 2, which supports the bell crank 1, as shown by the dotted arcs 7, 7. This appears to be what troubles H. C.

Then screw the valve stem 3 into the receptical 4 on the valve until the lower edge of the port in the valve laps over the lower edge of the lower port in the cylinder about ¼ in., then secure it.

Put crank on dead center and as the eccentric follows the crank, turn the eccentric around on the shaft until the desired lead is obtained, which for various reasons is to be kept as small as possible on any engine. Then so adjust the rods to the exhaust valves that they are line and line with wristplate centrals.

If engine is provided with 2 eccentrics, it is necessary to equalize the motion of the exhaust rocker arm and wristplate as explained for the steam valve.

Having accomplished this put the piston at about ¼ stroke and raise the governor to the center of its travel and move the cutoff pin to trip the valve at that point, the head end is provided with a device which when properly set will equalize the load between the 2 ends of the cylinder by turning a small screw which rotates the knockoff pin in the knockoff shaft.

On the same page and in same issue a reader inquires concerning the examination for second class fireman's license in Massachusetts. As far as operating boilers under a properly licensed engineer or the holder of an extra first class fireman's license is concerned, the second class and first class license men have equal privileges. The only conditions where the holder of a first class license scores over the holder of a second class license are that he may have charge of boilers in which the pressure does not exceed 25 lb. per sq. in., and may operate a plant of 50 hp. or a third class plant under a properly licensed man in charge.

To begin with, a thorough knowledge of the principle, use and importance of the water column and safety valve are necessary to anyone entrusted with the charge or operation of boilers. He should know how to ascertain the true water level in the boiler under all working conditions, how to renew gage glasses, supply the boiler with feed water and maintain an even feed suited to the evaporation. He should know the proper time and manner to handle the blowoff, methods of cleaning boiler inside and out, the importance of carrying a level fire that the least amount of excess cold air may enter.

What to do in cases of emergency, as safety valve sticking, low water, foaming, blowoff pipe burst, how to cut boilers into and out of the main,—these are among the most important to become familiar with, while the more one knows the better and more valuable man he is to employ, and this will have a good impression on the examiner. Other things such as manner of handling fires, cleaning boilers, the fireman would be instructed in from the engineer in charge.

In Massachusetts it is necessary that the applicant for examination for first class fireman shall have had at least 1 year's experience as engineer or fireman in charge of boilers or have held and used a second class fireman's license not less than 6 months.

It is advisable for the prospective applicant to apply for a first class fireman's license if he has had the necessary experience, because an examination is a trying ordeal for the best of men and if he should fail to pass for a first class license he probably would receive a second class and thus have something for his time and money. Should he apply direct for the second class license and fail he would have to wait 90 days before applying unless he appealed from the decision of the examiner; in that case he would be notified when to appear again. P. E. Merriam.

Boiler Problem

IN regard to R. E. W.'s question in the January 15 issue of Practical Engineer, I should like to say that I have handled both types of boilers, and I think the reason is the same as when Smith built a house; he put on a 45-deg. roof but Jones would not copy after him, and put a 35-deg. roof on his house, and both shed water if tight. W. M.

REPORTS STATE THAT THE transcontinental railway of Australia will use internal combustion engine locomotives.

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WHAT ABOUT RAW MATERIALS?

Working intensively, as every man must in this age of civilization, we frequently get to thinking of our own particular line of industry as the only one in which we are interested, and forget that our work is tied up closely with a lot of other things which do not seem directly connected.

At every mine there is of necessity a power plant of some kind, for pumping, ventilation or mine power, but in the manufacturing plant we sometimes lose sight of the great prime industries on which all other industries depend, namely agriculture and mining. These 2 furnish the raw material for all our manufacturing processes, and if they lag, all other industry must suffer. Without the material for food and clothing, high prices for these necessities must result. Without the ores for manufacturing, the high price of materials makes such manufacturing unprofitable, so that every man is interested in the success of these 2 great industries.

For many years agriculture has been given close attention by the government through the Agricultural Department, and large sums have been spent yearly, as is proper that they should be, in trying to improve our methods of agriculture and help out those engaged in it. The country now spends nearly $4,000,000 a year on experiment stations and agricultural colleges, and some $15,000,000 for carrying on the work of the Department of Agriculture. The progress in methods and results is notable and satisfactory and justifies the expense. A vast amount of valuable information has been accumulated, more than is being put into practical use by the farmers of the country. An additional appropriation is now asked to put this information where it will be effective. This is right and proper, and every citizen who is looking for the best interests of the country should endorse it and do what he can to have this enterprise put through.

On the other hand, the mining industry, probably because it is less widely distributed than agriculture, has not been given the attention that it deserves. The Bureau of Mines has been working on an expenditure of half a million dollars a year and has problems to solve which are fully as great and as complex as those involved in agriculture. Because of the small fund available, much of the work has been put on the prevention of fatalities and accidents in mines, and a marked reduction in such accidents has been the result. The necessity for such work is shown by the fact that more than 4000 men are killed each year in the mines and quarries, and 60,000 injured, leaving those dependent upon the men disabled to be cared for by the states. The figures from foreign countries show that at least half these deaths are unnecessary.

We are sometimes likely to think that the fatality in coal mines is greater than in others, because much work has been done in investigation of coal mine accidents, but as a matter of fact the Bureau of Mines states that the death rate in metal mines is higher than in coal mines, and the quarries have even a higher death rate than the metal mines. Nothing can, however, be done in the direction of safeguarding these lives until a larger appropriation is available for the work.

Besides this, the mining industry in the west is going backwards. In the 4 years from 1906 to 1910, the value of gold, silver, copper and lead produced in Colorado, Montana and Idaho fell off $50,000,000, and the number of men employed fell off some 23,000. The reason for this is that the high grade ores are becoming exhausted, and to treat low grade ores profitably involves the solution of many special problems in reduction which are akin to the problems of the farmer. They cannot be

solved by private experiment except in the cases of a few big companies having large amounts of capital, and these companies, when they have devised processes, keep them secret, thus barring the smaller companies from working the low grade ores.

If the general activity in mining industries is to be kept up, these problems must be solved and the knowledge made public property. This can be done only by the federal government. Unless this is done, the number of men employed in the western mining industries, and the amount of ores produced, will continue to decrease, thus forcing up the price of raw material and limiting the extent of manufacturing.

The Bureau of Mines has asked for $250,000 to begin work on these problems and on the question of safety in the metal mines. This is a very modest appropriation for the work and shows that the Bureau is expecting to start carefully and work economically. As compared with the extra $3,000,000 asked for by the agricultural interests, it is certainly a small amount, and if agriculture—one of our prime industries—deserves, as it certainly does, the large expenditures that are being made for it, our other prime industry, mining, deserves this minimum of attention.

Another great need of the Bureau of Mines is an adequate provision for buildings. At present its experiment station is located in Pittsburgh in buildings belonging to the War Department, some of which are 100 years old and much dilapidated. The Bureau is there by permission of the War Department, and that department is now asking for these buildings for its own use. The City of Pittsburgh has arranged to provide a site for such buildings as are needed by the Bureau of Mines, and an appropriation is asked of $500,000 to provide these buildings, $300,000 to be immediately available. The buildings asked for are: A Mining Engineering Building, to cost $100,000; a Mine Rescue Building, $40,000; Chemical Building, $100,000; Explosives Building, $30,000; Mechanical Building, $75,000; Fuels Building, $55,000; Service Building, $60,000, and for tunnels, pipe lines, sidings, storage bins and other equipment, $40,000. It is evident that to rent buildings suitable for this work will not be possible, but the cheapest sort of construction which will be durable and present a respectable appearance in a city is all that is intended; as Dr. J. A. Holmes, Director of the Bureau, says, "All we want is a floor and a roof and glass sides."

The work of the Bureau cannot be considered as an expense; it is an investment which is paying large returns on the money put into it. Within the past year the reduction of loss of life in the coal mines alone is not less than 500, but even at that the loss has been much greater than it should be, and the fatalities in the mines and quarries are yet to be taken up. Furthermore, by its investigations in fuels, the saving in actual cash to the government departments alone has been not less than $100,000 in the last 3 years, to say nothing of what has been saved to private corporations.

In 8 years the Bureau has been moved from place to place, because of having no permanent plant, at a cost of at least $150,000, so that the provision of a permanent plant, removing this item of expense, will pay a fair percentage on the money necessary for such a plant.

Taking it all in all, there is every reason why the Bureau of Mines deserves generous support from the country. The present time is critical, and every man should have a broad view of his interest in this work, which is as vital as the industry of agriculture. Whatever influence can be exerted by voice or by letter should be used to secure the passage of these appropriation bills.

OFF DUTY CHAT

Fire

"WHERE'S the fire?" This is the usual and natural inquiry when the bell or the whistle sounds and the engines and trucks go clanging down the street. And it expresses just what it sounds like, languid curiosity and that we take fires like floods and frosts as a matter of course.

For a real man's size, on-the-job question, we should ask, "Why was there a fire?" We spend thousands for means to stop the fire, yet we burn up millions every year. And we are just beginning to chirp feebly about taking heed to prevent fires. Isn't that just like our national sense?

Here we are trying to avoid damage by floods and frost, which we don't start, cannot stop; and must therefore try to neutralize the effects. And so we go at the fire problem the same way, when the starting of a fire is mostly our own fault. Nature doesn't often start fires in spite of us; lightning is practically the only source and that's so rare as to be negligible.

And where's the blame? Willard Done, Insurance Commissioner of Utah says there are 3 classes responsible; voluntary incendiaries, who set fires for gain or revenge; involuntary incendiaries who scatter half burned matches, cigars and cigarettes, leave bonfires smouldering, permit uncovered gasoline and oil cans, neglect leaky flues and dangerous wiring, and store oily waste and "sich" in barrels and boxes; and aids to arson who ask, "Was it insured?" and then condone or felicitate according as it was or wasn't.

As to the first class, the law for them and severely. As to the second, are we or our friends or acquaintances ever of it? Its intentions are not criminal, but the results may be as dire as those of the first class. The remedy? Watch the other fellow—and yourself.

But what's wrong with the third class? Isn't it a good thing to be insured? It certainly looks so when the fire has been in your own plant or house.

Firstly, the attitude of this third class is that fires are inevitable. Time was when smallpox and typhoid fever were looked at the same way. Secondly, the fact that a fire loss is "covered" doesn't prevent the drain on the nation's resources; it simply distributes it so that you and I bear part of the loss. And the greater the loss, the more we pay if we carry any insurance. Again this third class assumed that the insurance should be paid whether the loss is just or not; that is you and I who may take every precaution to prevent fire ought to help pay the loss of the man who may be utterly careless.

What does it cost us? Just about $225,000,000 a year; allowing one person in 10 as paying insurance, that's about $23 a year losses to be paid by each one. But this insurance cost, like all costs of manufacturing and selling, eventually comes back on the consumer in increased price of goods, so that to the average breadwinner the charge for national "carelessness with matches" is $4.60.

Oh, well! Figures can go on forever, but what's the use of being a fool when we don't have to. The remedy is right at home. First, careful inspection to see that proper safeguards are provided and rules adopted to prevent starting fires and to nip them early. Second, to take responsibility as workers and as individuals of seeing that such safeguards are properly maintained and rules carefully respected.

$225,000,000 is a neat little sum to save each year; even a half or a quarter of that saved and available to start new industries or provide comforts and pleasures would produce really worth while results.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

A NEW AUTOMATIC STOKER

THE Riley Self-Dumping Underfeed Stoker, which is just being offered to the public, was first built about a year ago, and has been in operation during this period in the plant of the Narragansett Electric Light Co., Providence, R. I., where it has had pronounced success. Tests and experiments on this original stoker have resulted in a few changes, and together with the rigid standardization of parts, has perfected this stoker.

The new stoker is characterized by simplicity, maintenance of even fire with a thorough air mixture, together with self-dumping features, and the breaking up of the clinkers inevitable from the use of certain grades of coal.

It has moving fuel bearing grates and moving overfeed grates extending across the entire width of the furnace, which carry the fuel down an incline of about 20 deg. The positively forced feed, made up of the combined motion of a plunger in the retort and the moving grates, distributes the coal evenly, so that nearly uniform thickness of fuel insures active combustion over the whole fire surface by providing free and uniform passage of air through the coal.

Discharge of refuse is continual and automatic. At the lower end of the overfeed grates are pusher noses which force the refuse slowly but continuously toward the bridge, then on and over the ash supporting plates which are hinged together in the form of an apron. The plates of this apron hang down over the ends of a rack which control the size of the opening and is adjustable by hand. The discharge capacity can be regulated by the amount of travel given to the pusher noses at such a rate that the fuel is burned out and cold before discharge.

Efficiency is secured in the Riley stoker by the underfeed, the homogeneous condition of the fuel bed, and the ratio of air to coal mechanically maintained. Flue gas analysis determines this ratio, which is kept constant, no matter how the load fluctuates, by driving both stoker and fan from the same shaft.

Continual reciprocating motion of the moving grates, which is in opposite directions for adjacent retorts, forms a shearing line between each pair, to prevent the formation of clinkers above the air openings. The prevention of clinkers on the top of the fire has an important influence on the repair expense as well as on efficiency and capacity. The shear between the moving retort side and the side wall of

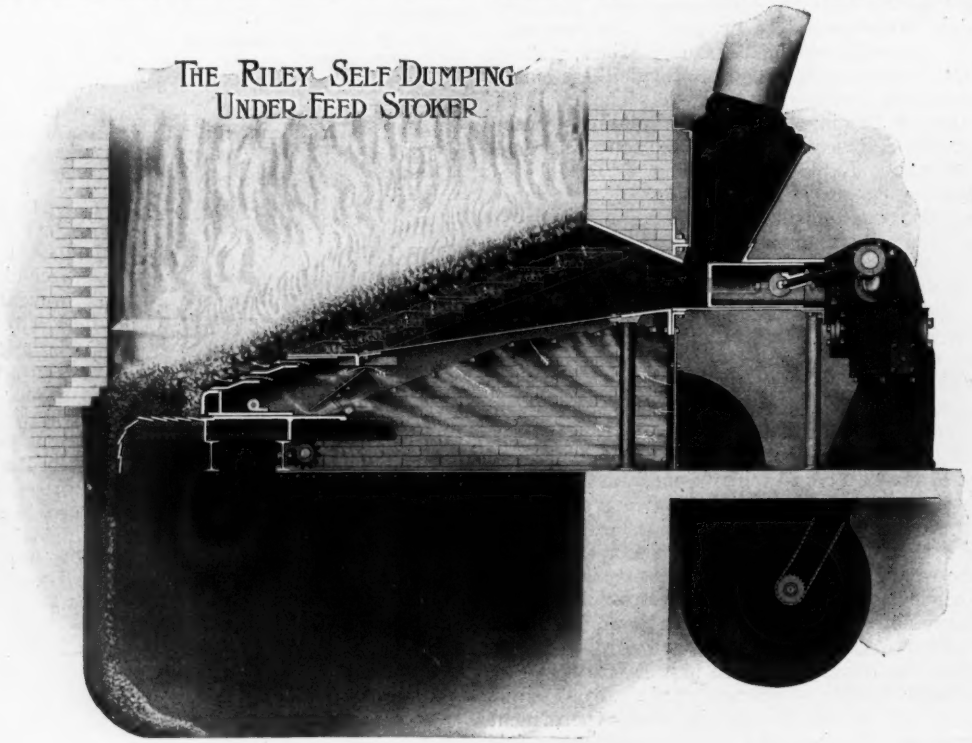

FIG. 1. SECTION OF RILEY STOKER

the furnace keeps the brick work free, and the crusher action of the pusher noses at the bottom of the overfeed grates is effective in preventing the accumulation of clinker of large size at this point.

With this new stoker there is one plunger for each retort which gives few parts required.

Strong, rugged construction throughout; all parts are made interchangeable without any fitting and with practically no rights and lefts, and provision so that an obstruction caught in front of a plunger will block that plunger only, and do no damage more serious than the shearing of a pin which forms the safety device are special mechanical features. This not only reduces the amount of fire area temporarily deprived of fresh fuel but reduces the labor of overhauling.

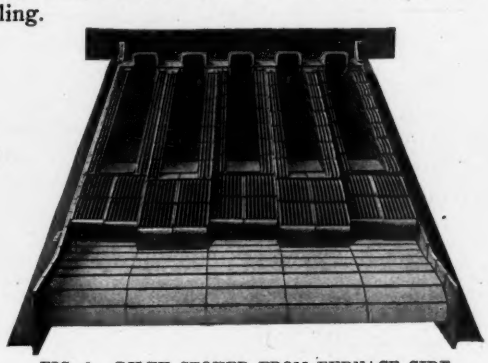

FIG. 2. RILEY STOKER FROM FURNACE SIDE

The simple driving mechanism of the Riley is visible from the outside and easily accessible, and the air space underneath the stoker may be reached through the door or through the opening in the front air plate on the side door. Whole sections may be disconnected at will from the driving mechanism, and removed or replaced without further disturbing any other part or section. The Riley stoker has a small width per horsepower.

Head-room required is small, which permits a large combustion chamber, and the complete separation of ash pit and fire room.

This stoker is made by the Sanford Riley Stoker Co., Ltd., Worcester, Mass.

NEW ELECTRIC SPEED INDICATOR

THE Brown Instrument Co. and the Keystone Electrical Instrument Co. of Philadelphia, Pa., are placing on the market a new electric tachometer or speed indicator to indicate accurately or record on a chart, the revolutions per minute of a rotating shaft or wheel, the indicating or recording instrument being located at any desired distance from the shaft, the speed of which is to be measured. The instrument consists of a small magneto or generator, particularly designed for use with this tachometer and which generates 25 volts at 1000 r.p.m. On account of the voltage generated, an instrument absolutely dead beat in operation can be supplied. Instruments have been particularly designed by the above companies of unusually high resistance, exceeding 3000 ohms in each instrument, so that the length of leads connecting the magneto or generator and the indicating instrument have no effect on the readings, and also one, 2 or 3 instruments can be connected to the same generator without affecting the indications, where it is desirable to place a recording instrument in the office, or at another convenient point.

In Fig. 1 is shown the standard Brown electric tachometer, generator, leads and indicating instrument as usually supplied, while in Fig. 2 is shown a group of instruments connected to a generator driven by sprocket and chain, 2 indicating instruments and one recording instrument being connected to the same generator to both indicate and record the speed at 3 different points.

FIG. 1. THE BROWN STANDARD ELECTRIC TACHOMETER

For holding large machine tools at the desirable cutting speed, for keeping blast furnace, gas or steam blowing engines at a constant speed so that a certain number of cubic feet of air per minute can be blown into the furnace, for tests which constantly have to be made, as an instance, locomotive tests which are

FIG. 2. BROWN INDICATORS AND ONE RECORDER CONNECTED TO ONE GENERATOR

run by several universities and larger railroads' departments the electric tachometer readily gives readings and records at the machine or at a distant point or both.

To anyone who desires to secure an indication of the speed or a constant record on a chart, the above companies will be glad to send a new bulletin describing the Brown Electric tachometer.

CUTTING LARGE PIPE

MACHINES for hand threading of large pipe have been perfected to the point where this is a comparatively easy task. Now comes a machine for hand operation which will as readily cut off large pipe, running from 2½ up to 6 in. diameter. This is a new Toledo tool, made by the Toledo Pipe Threading Machine Co., of Toledo, O. Cutting is done by 4 knives automatically fed by star feed, 2 of which are beveled across the edge and cut a V-shaped section, while the other 2 are square and

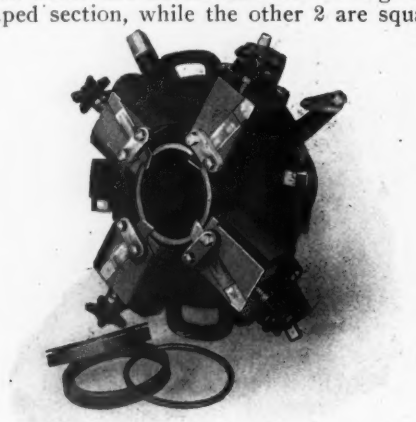

FIG. 1. THE TOLEDO PIPE CUTTER IN ACTION

following in the V cut sweep out the edges, thus preventing any tendency for the knives to bind in the cut.

Extra heavy pipe is cut as readily as ordinary pipe, merely taking a longer time because of the increased thickness. A 3-jaw chuck fastens the cutter to the pipe, each jaw being worked independently so that the tool can be quickly centered on the pipe.

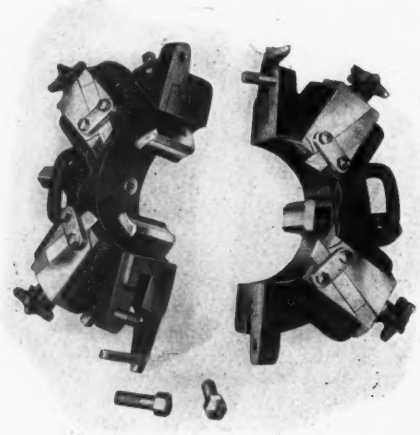

FIG. 2. TOLEDO CUTTER SEPARATED FOR PLACING ON PIPE LINE

Each knife is worked independently until it comes to the surface of the pipe, and all knives are then fed in automatically as the machine is revolved, the tool being driven by a pinion working on a beveled gear and operated with a ratchet handle. But little room is required on the pipe, so that a section only 1/16 in. long can be cut off if necessary.

The cutter is made in halves, bolted together, so that a pipe already in a line can be cut off and have fittings put on both ends, or a section of pipe having fittings on both ends may be cut in two. The knives are of special steel, so made that they can readily be reground as often as desired.

NATIONAL TUBE CO., 1913 EDITION BOOK OF STANDARDS

THE 1913 edition of the Book of Standards has just been received from the press. It contains 559 pages 4 by 6½ in. and is printed on Canterbury Bible paper; the book including the binding being not quite ⅝ in. thick will fit the pocket readily.

The information incorporated has made it strictly a pipe handbook and as such it will find an immense use with the trade. The index will be found very complete, all headings being thoroughly cross indexed. There are approximately 4000 references found in the index.

Several pages are devoted to a descriptive article covering the main process of manufacturing both welded and seamless tubes, also giving information in regard to the threading, durability and physical properties, etc., of the various kinds of pipes and tubings made. An article on protective coating, Matheson joint pipe, and Converse joint pipe contains desirable information on these subjects.

Tubular electric line poles receive considerable attention, various types of joints being described and illustrated. Full tabular information is given for poles from 22 to 40 ft., showing lengths of sections, size of butt, weight, thickness, greatest load pole will vary, etc.

Several pages describe, illustrate and contain tables in regard to lap, weld and seamless tubes, upset and expanded, wrought pipe bends, butted and strapped joints, bump joints, valves and fittings including various kinds of nipples and flanges, land buildings and ladders, working barrels, cylinders, Shelby seamless specialties, physical properties of carbonic acid gas, Briggs standard holding power of boiler tubes, thermal expansion of iron and steel tubes.

Considerable prominence is given to articles on strength of tubes and cylinders under internal fluid pressure and collapsing pressures. Both of these papers are very complete and have been extracted from papers by Prof. R. T. Stewart, Dean of Mech. Engr. Dept., University of Pittsburgh, and read by him before the A. S. M. E. Several of the formulas are compared and results of actual tests are given. Tables which show the probable collapsing and bursting strengths of standard tubes, will benefit the mechanical engineer, especially in the connection with boiler engineering problems.

An article covering pipe used as columns is given with tables showing the use of standard, extra strong, and double extra strong pipe based on the New York Building Code as well as the Chicago Building Ordinances.

Considerable attention is given to the mechanical properties of solid and tubular beams, of usual and unusual shapes. As tubing is finding considerable usage in the mechanical field, notably in automobile construction, this data is particularly useful. This article is accompanied by tables giving the mechanical properties of solid and tubular beams of uniform cross

section, various conditions of loading are illustrated and formulas are shown to secure their physical properties values. Unusual shapes are illustrated and formulas given to secure their properties as beams or columns.

An article on safety factors and safe working stresses is given, which shows through what ranges, values should be used for safe operation.

Chapters are supplied giving information in regard to water, gas, steam and air. It has not been the intention to go deeply into these various subjects, only in so far as they concern tubular products.

Several pages are devoted to area and weight factors for tubes and pipes by means of which it is readily possible to figure the area and weight of various kinds of tubing.

A special table is shown by means of which it is possible to find directly the weights of nearly all sizes and thickness of steel tubing up to 36 in. in diameter. By means of factors weights of various other metallic tubing can be found.

A table showing properties of tubes and round bars gives circumference, area, weight, surface in square feet, volume, moment of inertia, radius of gyration, etc., for tubes and bars up to and including 36 in. This data is given in increments of 0.01 in. up to 16 in. and increases from there by ⅛-in. increments to 36-in.

The metric system is included with conversion methods for most of the more commonly used measures including temperatures.

A glossary of terms used in the pipe and fittings trade will be found in the back of the book and in many instances the meanings of many of the more or less well known words used in this trade are defined.

Copies can be had from the National Tube Co., Pittsburgh, Pa., for $2 each.

EVAPORATORS FOR REFRIGERATING PLANTS

ONE of the greatest difficulties in connection with the production of pure colorless and odorless distilled water for making ice has been the rusting effect carried into the water from contact with iron or steel portions of the apparatus. Infinitesimal as this may appear, from a casual examination of the apparatus to be used for this purpose, it seems to be magnified many-fold by the time the ice is formed, all impurities of every sort being concentrated at the center of the cake, at which point the rust shows up in the form of ruddy streaks. Inability to cope with this situation has caused the despair of many a manager in such a plant.

In the type of Swenson evaporator which has been especially designed for this purpose, the water is not permitted to come in contact with any ferric material. Tubes and tube-plates are brass, which is proof against the picking up of impurities by the water in passing through. As a result, the can ice made from water distilled in this way is absolutely pure and free from air and other noncondensible gases, as well as from iron rust, oil and other substances producing color, odor or dust.

Another feature of ice production which is frequently not satisfactorily provided for, is the relation of distilling capacity to the other operations of the plant. This can be met only by having the apparatus designed by an experienced refrigeration engineer one who has successfully put in operation plants of this character and who is therefore competent to proportion the different factors one to the other. The number of effects most economically used in producing the distilled water will depend upon local conditions, the entire layout being designed to produce distilled water of absolute purity.

This is the latest line into which the Swenson Evaporator Co. has gone, the experience in half a dozen other industries having developed the evaporating apparatus to the highest possible efficiency. It required only the specific application of well established apparatus to a new use to make a thorough success of the new field.

NEWS NOTES

AN IMMENSE POWER PLANT is being constructed on the south side of the Kanawha River, at Cabin Creek Junction in the heart of the Kanawha coal field in West Virginia. The power plant, where electricity will be generated for use at the mines and for transmission to cities in the Kanawha and Ohio Valleys, is one of a chain of plants to be constructed throughout the Kanawha and New River canons. Within a few years, the promoters expect to supply electric power to every coal operation in the Kanawha and New River fields.

THE SOUTHERN POWER CO., of Charleston, N. C., having bought the Hickory Light and Power Co. from Col. Thornton for $65,000, the people of Hickory naturally expect further development in that section by the company. Engineers of the Southern Power Co. have for several weeks been engaged in surveying in the neighborhood of Lookout Shoals with a view to selecting the best site for the power plant, which is expected to develop from 16,000 to 20,000 hp. The decision as to the exact location has not been given, W. S. Lee stating several days ago that a complete investigation of all the available sites would be made before decision was reached. The area in which there is a probability of its being located comprises a corner of each of the counties of Catawba, Caldwell and Iredell.

RAPID GROWTH during the past year of The Griscom-Russell Co., the successor to The Griscom-Spencer Co., Russel Engine Co., and The James Reilly Repair & Supply Co., was celebrated by a dinner given to Clement Acton Griscom, Jr., President of the Company, by the G-R Lunch Club, which is composed of the officers and heads of departments of the company. The particular occasion for the celebration was the completion of Mr. Griscom's first year in the active management of the business, and his twenty-first year as president of the company.

Nearly one hundred members of the staff attended, including the New York sales, engineering and accounting forces, and the cost and office staff and foremen from the Jersey City Shops. The Works at Massillon were represented by Arvine Wales, vice-president, and R. J. Pabodie, works manager. G. V. S. Michaelis, vice-president and treasurer, was toastmaster.

IT IS REPORTED that several Birdsboro, Pa., people have bought the old Smith mill property along Six Penny Creek and intend to erect an electric plant to supply the community with power for lighting.

AN EXTRA SET OF MACHINERY is being installed at the Osceola, Iowa, Light, Heat and Power Co. plant which is to furnish power to supply the town of Murray with electric light.

NACODOCHES, TEXAS, is preparing to build a municipal light plant at a cost of approximately $30,000. Bids have been asked for labor and material, and the project is practically assured.

BALLINGER & PERROT have completed drawings and specifications and invited bids for additions to the power house of Charles W. Young & Co., between North Twenty-sixth Street and West College Avenue, Philadelphia, Pa. The building will have a frontage on Twenty-sixth Street of 36 ft., and a depth of 64 ft.

THE CHICAGO OFFICE of the Nelson Valve Co., Philadelphia, is now at 174 N. Market St. McMaster-Carr Supply Co. will act as direct representatives carrying full stock of Nelson valves, having arranged to give prompt attention to all inquiries and orders on the full line of iron, brass and steel valves.

G. R. GRIFFIN, general manager of the Tri-State Railway & Electric Co., announces that his concern will build a $2,000,000 powerhouse on a site near Midland, Pa. The company has obtained control of coal mines near at hand for fuel. The J. C. White Engineering Co., New York, will have charge of the work.

LEONARD GOODWIN, recently of the Boston office of Lockwood, Greene & Co., has been appointed manager of its Chicago office, in the First National Bank Building. Harold V. Coes, formerly manager at Chicago, has been transferred to the Boston office to assume charge of special work.

THE H. W. JOHNS-MANVILLE Co. announces the removal of its Newark office to 239 Halsey St. This new office and salesroom is located on the ground floor of a modern building in the heart of the city's business center. With a floor area of 4000 sq. ft., ample space is afforded for the display of the company's varied line of products.

A MANUFACTURER IN CAMBRIDGE, Virginia, recently had occasion to inquire into the matter of exhaust fans. He remembered that there was a manufacturer of such machines in Detroit, but did not recall the name, consequently addressed his letter "Manufacturers of Blowers for Planing Mills, Detroit, Mich.," which letter was promptly delivered at the office of the American Blower Co.

ROCHESTER RAILWAY & LIGHT Co. is planning to enlarge its South Water St. station again. This station was enlarged in 1905, and again in 1910, but increased demands for power mean that another enlargement is necessary. The floor space will be doubled, the new part being of brick and steel. The machinery has been ordered for October delivery.

THE WESTERN ECONOMIC SOCIETY, whose offices are at 58th St. and Ellis Ave., Chicago, is planning a conference on March 14 and 15 at the Hotel Sherman, Chicago, on the subject of Scientific Management and the Reduction of Waste in Materials and Labor in the Industries of the Country. Many eminent men have accepted invitations to be present at the conference and to present papers upon the different features of waste elimination.

AT DONALDSONVILLE, LA., a new power-house which will occupy a portion of the site of the present plant is to be erected. Contracts for machinery and apparatus to be used in modernizing the plant have been awarded. It is hoped the new system will be in operation early in the summer. The improvements include the installation of Deisel engines and electric-driven pumps.

VANDA PACKING Co. has removed its New York office from 96 Spring St. to Madison Ave. and 25th St.

AT ELMIRA, N. Y., drillers have started work on the East Water St. ground upon which the new power plant of the Elmira Water, Light & Railroad Co. will be erected this coming spring and summer.

THE BRANCH OFFICE MANAGERS and selling engineers of the American Blower Co. met for their annual convention at the Hotel Pontchartrain, Detroit, January 23, 24 and 25. Enthusiasm with regard to the business of the past year as well as prospects for the future was evident throughout all the sessions. Questions relating to engineering, salesmanship, administration, works-management and production were discussed at considerable length.

W. E. HARDY, formerly manager of the Diamond Mechanical Branch of the Diamond Rubber Co. at New York City, has succeeded I. R. Bailey as sales manager of the mechanical rubber goods department of the company. Mr. Hardy assumed his new duties January 15, 1913.

Mr. Hardy and his organization will continue to serve the trade in a manner that will merit future inquiries.

THE WORK OF RECONSTRUCTING the plant of the Clark-Gay Manufacturing Co., one and one-half miles southwest of Little Rock, Ark., has begun. A modern and more pretentious structure than the one destroyed by fire on January 14 will be erected.

The most up-to-date machinery will be placed in the new building and a concrete boiler house will be built to avoid danger of fire. The building will also be fitted out with an automatic sprinkler. The cost is not yet known as the plans are but partially drawn. In the meantime all wagon spokes and hubs, staves and headings will be manufactured on temporary machinery.

THE TERRY STEAM TURBINE Co. announces that on and after Feb. 15, the general sales office will be removed to the works at Hartford, Conn., and will be under the direction of Norman L. Snow. The New York office will remain under the charge of Frederick D. Herbert, as in the past.

Refrigerating and Engineering Ltd., Somerset Block, Winnipeg, have been appointed agents for the same company, for the territory represented by Manitoba, Alberta, and Saskatchewan. The Terry Co. already has agents at Toronto and Montreal, Canada.

Robinson, Cary & Sands, St. Paul, Minn., have been appointed Northwestern agents for the company. They will give particular attention to Minnesota, North and South Dakota territory.

THE STANDARDIZATION PROCESSING Co.'s plant at Chattanooga, Tenn., which is being erected near the Chattanooga Coffin Co.'s plant, is being rushed to completion. The brick work has been finished as high as the second floor, and work on the roof will be begun at once. Every effort is being made to have the building ready for business soon. Additional contracts have also recently been let for a brick boilerhouse, 41x41, and a boilerhouse, 45x100 ft. The superintendent and foreman, when operations begin, will probably be taken from the Coosa Mfg. Co., of Piedmont, Ala., a plant handled by the same people interested here. There will also be employment for approximately 40 men and women in the office and factory work. The line of work handled by the company is a process of mercerizing cotton goods, giving a silk effect. Their business will be with knitting and hosiery mills.

At Denison, Texas, the Diamond Ice Co. has begun the erection of its plant. Machinery and other equipment capable of manufacturing 30 tons of ice every 24 hr. has been ordered. This will give Denison 2 ice plants with a combined capacity of 130 tons daily.

In September, 1913, the meeting of the refrigerating interests of the world will be held in Chicago, and at the same time an exposition of refrigerating apparatus will be installed in the amphitheater at 42nd and Halsted Sts. It is expected that some 600 delegates will attend the Refrigeration Congress from Europe, South America and other parts of the world, and that the exposition will be the most complete ever brought together of refrigerating machinery and processes. The General Manager of the exposition is Wm. E. Skinner, 819 Exchange Ave., Chicago, from whom full particulars in regard to the exposition can be obtained by anyone interested.

A series of consular reports on the markets for American-made machine tools in Latin America will be issued in the near future by the Bureau of Foreign and Domestic Commerce. Lists of firms and individuals who sell and use machine tools in the various countries are a valuable feature, and considerable attention is given the sales methods, credit terms, etc. The Latin American countries are largely agricultural and the demand for machine tools has consequently been limited, but there is an increasing use of machinery of this sort in some localities in Latin America especially in connection with railroad repair shops.

Providence Engineering Works, Providence, R. I., has been reorganized and will resume work building the Rice & Sargent Corliss engine and continuing its contract work as before.

The personnel of the corporation is a strong one and includes James Coulter and Norman Leeds, who are both prominent in the management of the Automatic Machine Co., Bridgeport, Conn. Mr. Coulter will have the mechanical and engineering supervision of the Providence Engineering Works. Associated with him on this side of the management will be the old engineering staff of the company. Richard A. Robertson remains as President of the corporation and will continue to participate actively in the management. The other officers are as follows: Vice President, James Coulter; Treasurer, Norman Leeds; Assistant Treasurer and Secretary, Frank L. Vaughan. The directors are President Robertson, Vice President Coulter, Treasurer Leeds, Assistant Treasurer and Secretary Vaughan and James M. Scott, Randolph T. Ode and Arthur A. Fuller, Providence; V. Everit Macy and F. Kingsbury Curtis, New York City.

The Providence Engineering Works has now been discharged from the hands of the receivers and has begun business on a new basis. The house was founded in 1829 as the Thurston & Gardner Co., and 30 yr. later became the Providence Steam Engine Co., which name continued until 1899, when the business was incorporated under its present name.

The New Jersey and New York Power Corporation will spend between $8,000,000 and $10,000,000 in damming the Neversink River and constructing a power plant near Monticello, N. Y. The plant will be for generating electricity which, it is unofficially stated, will be used to electrify the Erie Railroad, the impression prevailing that the J. P. Morgan interests are back of the enterprise.

The dam will be over 800 ft. long and will cost about $3,000,000. The valley will be flooded back for 15 miles and will completely engulf what is now the village of Bridgeville. A tunnel more than 3 miles long will be cut through the Shawangunk Mountain to the valley of Haven. A branch railroad will be built from the dam to connect with the Port Jervis and Monticello Railroad at St. Joseph's station.

Representatives of the company say that work will be commenced in early spring and that 3000 men will be employed. Six years will be required to complete the plant.

BOOK REVIEW

Alternating-Current Machinery. By Wm. Esty, 467 pages, bound in half morocco, 6½ by 9½ in. This treatise has been prepared with the special object of giving the beginner and the so-called practical electrician a working knowledge of alternating-current apparatus, in order that he may know how to install and operate it intelligently. The book contains no mathematics beyond the simplest trigonometry and great pains have been taken to make the description, explanations and proofs simple and clear.

The Bureau of Mines announces the following new publications:

Second Annual Report of the Director of the Bureau of Mines, 1911-12; J. A. Holmes, Director, 1912; 88 pp.

Bulletin 45; sand available for filling mine workings in the Northern Anthracite Coal Basin of Pennsylvania, by N. H. Darton; 1912; 33 pp.; 8 pls.

Technical Paper 32; the cementing process of excluding water from oil wells as practiced in California, by Ralph Arnold and V. R. Garfias; 1912; 10 pp.

Miners' Circular 11; accidents from mine cars and locomotives, by L. M. Jones; 1912; 16 pp.

The Bureau of Mines has copies of these publications for free distribution, but cannot give more than one copy of the same bulletin to one person. Requests for all papers cannot be granted without satisfactory reason. Those asking for publications are requested to order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

An Extension of the Dewey Decimal System of Classification Applied to the Engineering Industries, by L. P. Breckinridge and G. A. Goodenough, was originally issued as Bulletin No. 9 of the Engineering Experiment Station in 1906.

The filing and classification of engineering data has become a matter of much importance, and this bulletin was prepared for use as a guide in carrying out such work. The original edition of Bulletin No. 9 was subject to the usual gratuitous distribution, and the subsequent demands were such that a second edition was printed and ultimately distributed. Altogether 20,000 copies were sent out. The demand having continued it was finally decided again to revise and to print a limited edition. This has now been accomplished and the revised bulletin much extended as compared with the original edition, is ready for distribution. It presents subdivisons of subjects in such detail as to constitute a complete classification for most engineering industries, even though they are highly specialized. The revision has been made in accordance with the 1911 edition of "Decimal Classification". by Melvil Dewey.

The revised edition of Bulletin No. 9 will NOT be subject to gratuitous distribution. A copy will be sent post-paid upon the receipt of fifty cents by W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

SINCE THE DISCOVERY of the X-Ray by Roentgen, our views concerning the composition of matter have undergone a great change. We know now that many of the commonplace occurrences of everyday life depend on the actions and activities of particles too small to be rendered visible, even under the most powerful microscope. The methods which scientists have used to study these actions have been marvelously ingenious and delicate. Especially our notions as to the precise nature of electricity and magnetism have changed. These are matters which are discussed chiefly by mathematical processes in Bulletin 62, just issued by the Engineering Experiment Station of the University of Illinois. The Bulletin is entitled "The Electron Theory of Magnetism," and its author is Dr. Elmer H. Williams of the Department of Physics.

Copies of Bulletin 62 may be obtained upon application to W. F. M. Goss, Director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

CATALOG NOTES

THE LARGEST AND MOST COMPLETE production catalog ever issued by the Joseph Dixon Crucible Co., Jersey City, N. J., is now being mailed to the thousands of manufacturers, jobbers, purchasing agents and others interested in graphite, crucibles, paint, lubricants, pencils and the other productions of

the company. Though over 100 pages of type and illustrations are used, this catalog does not attempt to carry a full description of the entire line and only a few of the many hundreds of Dixon's American graphite pencils are listed. If you are particularly interested in the many forms and uses of graphite you are invited to send for a copy of this catalog.

LEAD LINED IRON PIPE CO., of Wakefield, Mass., has issued its 1913 calendar with colored illustrations showing cross sections of its pipe.

A TRUE SPORTSMAN is characterized in a suggestive paragraph quoted on the artistic calendar issued by the American Steam Gauge & Valve Manufacturing Co.

SPRAGUE ELECTRIC WORKS of General Electric Co. has issued an illustrated pamphlet, No. 117, which supersedes No. 114 and gives a brief outline of the principal Sprague electric products.

"TANTALLON CASTLE, North Berwick, Scotland," reproduced by color photography from the original painting by Thomas Moran, is a sea view decorating a large and handsome calendar from Morris Machine Works, Baldwinsville, N. Y.

CATALOG No. 1200 from The Bristol Co., Waterbury, Conn., contains 48 pages on the company's recording thermometers, for temperatures between 90 deg. F. and 500 deg. F.

Bulletin No. 138 from the same company describes its electric time recorder for recording time of mechanical movements, machine operation, valve reversals, etc.

Bulletin No. 139 describes Bristol's mechanical time recorder for continuously recording time and extent of mechanical movements.

THE GENERAL ELECTRIC CO. has recently issued Bulletin No. A4004, which describes the G-E steam flow meter. This bulletin supersedes the company's previous bulletin, No. 4836, on this subject; Bulletin No. A4039, which is devoted to direct-current motor-starting and speed-regulating rheostats and panels, supersedes previous bulletins, Nos. 4600, 4559 and 4532, on this same subject.

TRADE NOTES

DEMAND in Salt Lake City, Utah, and vicinity, for J-M asbestos roofing, shingles, pipe coverings, and other products manufactured by the H. W. Johns-Manville Co., has increased to such an extent, that this company has found it expedient to open a branch office in the Dooly Block, in that city, which will materially facilitate the handling of correspondence, orders, etc.

IN THE NEW building of the Maryland Casualty Co., at Baltimore, Md., is installed a thoroughly modern power plant for furnishing heat, light and ventilation, as well as modern conveniences of cooled drinking water, vacuum cleaning and fire protection. The sources of power are a bank of 3 150-hp. Heine water-tube boilers with superheaters, to give steam at 150 lb. pressure and 100 deg. F. superheat, and 3 Lentz engines with poppet valves specially adapted to use superheated steam and driving direct Westinghouse generators of 125, 75 and 50 kw. capacity, delivering current on the 3-wire system at 250-125 volts.

THE AMERICAN ENGINE CO., of Bound Brook, N. J., has received an order from the Portland Iron Works, Portland, Oregon, for 2 1000-hp., triple expansion, angle type engines for use on 2 Government dredges being constructed by the Portland Iron Works. The engines will be of the twin-angle type with 2 horizontal and 2 vertical cylinders, the 2 vertical being the low-pressure, and will be directly connected to a large centrifugal pump. This type of engine was selected because, being well balanced, it operates at comparatively high speed thus permitting a more advantageous design of centrifugal dredge pump. The angle arrangement also eliminates vibration and pounding and saves floor space, all of which are desirable features for this service. The company states that it has a large volume of orders on its books, and that the business outlook for the coming year is excellent.

YORK MANUFACTURING CO. reports the following among recent installations:

Border City Ice & Cold Storage Co., Fort Smith, Ark., one 175-ton vertical single-acting refrigerating machine and compression side; Kent Co., Ltd., Montreal, Canada, one 30-ton, refrigerating, horizontal, double-acting machine for Island Cold Storage Co., Ltd., Prince Edward Island, Ontario, Canada; Ville Platte Light & Ice Co., Ville Platte, La., one complete 15-ton flooded can ice making plant with vertical, single-acting compression side; Schantz Co., New York, N. Y., one 20-ton, vertical, single-acting, belt-driven compression side and brine refrigerating system for Maine Creamery Co., Providence, R. I.; Manhattan State Hospital, Wards Island, N. Y., one 50-ton, horizontal, double-acting, steam-driven compression side; D. Kinnah, Princeville, Ill., one 4-ton, belt-driven compression side and refrigerating plant; Federal Tool Co., East Boston, Mass., one 11-ton, belt-driven compression side and water cooling plant; Surgeon Bros., Bocas Del Toro, Panama, one 4-ton, belt-driven compression side and 2-ton ice making plant.

Sparks From The Advertising Pages

"We look upon all of our advertising as an investment. The moment that any part of it begins to look like expense, that part is put under a microscope, analyzed more thoroughly than ever and if it continues to look like expense, we stop it and begin to put the money into something else.

"As a matter of fact, we never really feel that our advertising is actually costing us anything; for we study our situation so thoroughly that we're just about sure that something's worth more than a dollar to us before we spend a dollar to buy it.

"Of course we can't always see the dollar plus value for each dollar spent right off the reel in a tangible way, but we do make it a point to be always satisfied in our own minds that the ultimate value will be at least equal the price we paid for it."

Thus spoke the advertising manager of a big Eastern Manufacturing concern recently in discussing his firm's appropriation for the current year—a man who looks after the investment of big sums of money annually.

His advertising is an investment because he spends money for something from which he will realize future benefit—benefit which is profitable in relation to the amount invested.

If it were an expense, the benefit derived would end with the purchase and there would be no profitable returns in the future.

An advertiser can make his advertising appropriation an investment or an expense as he chooses. Careful study and discriminating judgment in spending it will make it pay.

In the same way, the manner in which you read the advertisements makes you either an investor or a spender.

If you take a minute now and then to look through the advertising pages, glance casually at a striking illustration which catches your eye, or note with momentary interest a diagram YOU HAVE SPENT THAT TIME and you have realized no permanent value therefrom. Its value to you was measured by the fleeting interest of the moment.

On the other hand if you take time to study what the advertiser has taken much more time to write—if you pay close attention to ALL of the advertisements, spending sufficient time upon them to get an intelligent understanding of the product which they tell you about, you have invested your time and you can expect it to yield you future value.

And why not?

Knowing every product which is advertised—being familiar with the advantages of these products—will certainly put you in a position to judge with keener and more valuable discrimination—will add to your personal efficiency.

And this stored-up knowledge will assuredly stand you in good stead at some future time.

Nearly every reader uses some of his time to look through the advertising section. Some invest this time—others spend it.

How about the time which you use? Are you an investor or a spender?

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office 10 days preceding publication.

Positions Wanted

POSITION WANTED—By first class Ohio Licensed Stationary Engineer; 15 years experience. Wishes position as chief engineer in steam power or large building or steam electric power plant; best of references; married man; 31 yrs. of age. Wm. Wisely, 1318 Yondota St., E. Toledo, Ohio. 3-1-1

POSITION WANTED—By Chief Engineer. 20 years in charge of large power plants. Thorough knowledge of steam, electrical, hydraulic and refrigerating machinery. Life study of scientific management. Total abstainer. W. F. Bonsman, 945 Front Ave., Grand Rapids, Mich. 3-1-1

POSITION WANTED—BY YOUNG MAN as oiler or engineer helper. Strictly sober and reliable man, willing worker. Address Olaf Ackley, H, P. Station, Des Moines, Ia. 3-1-1

POSITION WANTED—Bv middle aged man as engineer. Holds 2nd class Massachusetts License. Have had experience in electric light and power plants. Will go anywhere. Present position four years. Total abstainer. Can give best of references. Address R. W. Plummer, 39 Norcross St., Lowall, Mass. 3-1-1

DO YOU NEED MEN?—All clerical, commercial and technical departments. Charges low,—one reason we get efficient men. Efficient Service Co., 1340 Monadnock Bldg., Chicago.

Wanted

WANTED—WE HAVE a proposition for every engineer who has a little spare time and a big desire to increase his income. You can introduce to your engineer friends a staple engine room necessity and derive permanent profit from all repeat orders. Our proposal is attractive and a little effort does the trick. If you are interested, write to Suite 2710, 165 Broadway, New York. 3-1-1

WANTED—IF YOU KNOW the peculiarities of a steam boiler—its "ins and outs"; if you can talk with conviction; if you're sober and a hustler—we have an opening that you might fill to our mutual advantage. A practical engineer who has had selling experience, or one who thinks he can sell Boiler Specialties on a basis of remuneration that we know will prove attractive, will receive full particulars promptly on receipt of application. Write us. Address Box 278, Practical Engineer, Chicago, Ill. 2-15-2

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—SALESMEN calling on firms with stationary engineers, to write us for desirable open territory, where they can soon build up permanent business with our guaranteed product insuring repeat orders. Address 322 Real Estate Trust Bldg., Phila., Pa. 2-15-24

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once. tf.

WANTED—SALESMEN SELLING Steam Plant Supplies, to carry as side line, ideal pump valves and plunger packing. Best Valve proposition on the market. Liberal commission and protection in territory allotted. Several entire and part States open. Sample weighs four ounces, easily carried in pocket. If you are looking for a good side line, address, giving full particulars as to territory covered. Lake Erie Boiler Compound Company, Buffalo, N. Y.

WANTED—A SALESMAN familiar with the handling of moderate power internal combustion engines. Address Box 275, Practical Engineer, Chicago, Ill. 2-15-2

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

Help Wanted

WANTED—An additional subscription solicitor wanted to cover towns in state of Washington. Excellent chance to earn extra money. Write to Subscription Department. tf.

WE NEED MEN—All departments—clerical, commercial and technical. Charges low. Work covers the U. S. Efficient Service Co., 1340 Monadnock Bldg., Chicago.

For Sale

FOR SALE—FOUR DIRECT CONNECTED engine and generator sets 25 to 75 kilowatt capacity. Two 17x15-inch straight line engines, built for direct connection or belted service. One 14x12-inch, late type, automatic and one 16x36-inch Corliss engine, water tube and horizontal boilers of all sizes. Twenty-two round, open steel tanks 10 feet 6 inches by 7 feet high. H. P. Brearley, 90 West St., New York, N. Y. 2-15-4

FOR SALE—Three 150 H.P. HRT. Boilers (Massachusetts specifications), quadruple riveted, double butt strapp, 140 lb. insurance certificate, $550 each. Duzets & Son, Hudson Terminal, New York.

FOR SALE—A 32 H. P. HORNSBY-AKROYD Oil Engine with starting device, in very good condition; also a 15-ton Challoner refrigerating machine, oil separator, double pipe ammonia condenser and high and low pressure gauges. These are also in good condition. For particulars inquire of the Rahr Br'g Co., Oshkosh, Wis. 1-1-6

Patents and Patent Attorneys

FIND OUT FOR YOURSELF what to invent and how to procure and sell a patent for the same. My book, "Inventor's Universal Educator," covers the matter from A to Z. 140 pages, elegantly bound. Also contains 600 mechanical movements and 50 perpetual motions. Price $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C. 3-1-1

PATENTS AND TRADEMARKS secured. Write for terms. Harry Patton, 330 McGill Bldg., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C. tf.

THE PATENTOME is interesting and instructive. A liberal education in patents and how to get them. Free on request. Established 1865. Anderson and Son, Patent Solicitors, 710 G Street, Washington, D. C. 3-1-2

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee will be mailed every subscriber sending in one new subscription to Practical Engineer. Gilt edges, bound in leather. tf.

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash-Younker Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf.

REFRIGERATION—Any engineer desiring a working knowledge of Ice and Refrigerating machinery should study "Audel's Answers on Refrigeration"—just published in two parts, written in plain language—price $4, postpaid. Money back if not pleased. Catalog free. Theo. Audel & Co., publishers, 72 5th Ave., New York. 2-1-6